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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 10. EUDICOTS: BERBERIDACEAE, BIGNONIACEAE, AND BORAGINACEAE

RICHARD STEPHEN FELGER
Herbarium, University of Arizona
Tucson, Arizona 85721
&
Sky Island Alliance
P.O. Box 41165
Tucson, Arizona 85717
Author for correspondence: rfelger@email.arizona.edu

SUSAN RUTMAN
90 West 10th Street
Ajo, Arizona 85321
tjt@tabletoptelephone.com

C. MATT GUILLIAMS
Santa Barbara Botanic Garden
1212 Mission Canyon Road
Santa Barbara, California 93105
mguilliams@sbbg.org

JIM MALUSA
School of Natural Resources and the Environment
University of Arizona
Tucson, Arizona 85721
malusa@email.arizona.edu

ABSTRACT

A floristic account is provided for three eudicot families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the heart of the Sonoran Desert of southwestern Arizona: Berberidaceae with 2 species, Bignoniaceae with 1 species, and Boraginaceae sensu lato with 34 modern species plus one fossil species no longer present. Among the 3 families, at least 13 of these species are also known from fossils recovered from Ice Age packrat (*Neotoma*) middens. This is the tenth contribution for this flora, published in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ).

This contribution to our flora in southwestern Arizona (Figure 1) is the tenth published in a series in Phytoneuron and also posted open access on the website of the University of Arizona Herbarium (ARIZ). Three eudicot families are included in this contribution: Berberidaceae (1 genus with 2 species, and at least 1 species represented by fossils); Bignoniaceae (1 genus with 1 species), and Boraginaceae sensu lato (14 genera with 35 species, including 12 species represented by fossils). (Table 1). There are no non-native taxa in the flora area among the 3 families.

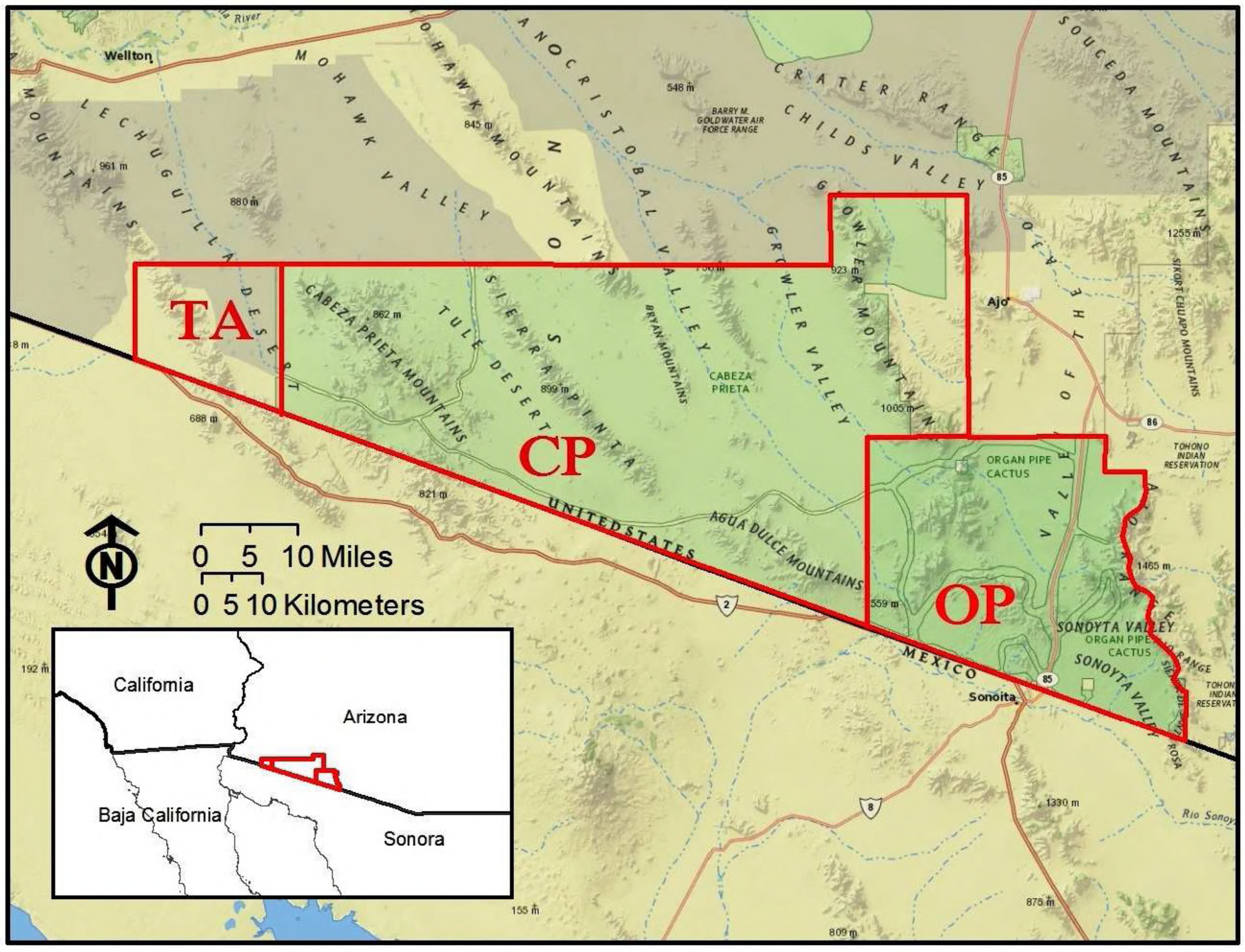

Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas. CP = Cabeza Prieta NWR. OP = Organ Pipe Cactus NM. Green shading indicates approximate boundary of federally designated wilderness.

Family designations follow APG III (Angiosperm Phylogeny Group 2009; also see Stevens 2001). Fossil specimens are indicated with a dagger symbol (†) and the one fossil taxon no longer present in the flora area is marked with two dagger symbols (††). In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish, and the Hia C-ed O'odham dialect, respectively (Spanish-language names are italicized). The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact. The identification keys are for the modern flora.

All photos and scans are by Sue Rutman unless otherwise stated. Photos of borage floral parts and nutlets are by Michael G. Simpson and students, San Diego State University (www.sci.sdsu.edu/plants/boraginaceae). All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2013). We have seen specimens or images of all specimen cited. When no collection number is provided, the specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region (Figure 1). Additional explanation of the format for this flora series is provided in part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

Table 1. Local distributions and growth forms of Berberidaceae, Bignoniaceae, and Boraginaceae for the flora in southwestern Arizona. † = Modern taxa also represented by a fossil specimen(s), †† = fossil taxon no longer present in the flora area (not counted in the totals). OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, TA = Tinajas Altas Region. SU = Summer/warm season ephemerals, WI = cool-season/winter-spring ephemerals, AP = facultative annuals or perennials, and PR = perennials.

Taxon	Region			Growth Form			
				Ephemerals			
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Summer	Winter	Facultative annual or perennial	Perennial
BERBERIDACEAE							
†*Berberis haematocarpa*	OP						PR
Berberis harrisoniana	OP						PR
†*Berberis* sp.	(OP)						(PR)
BIGNONIACEAE							
Chilopsis linearis	OP	CP					PR
BORAGINACEAE							
†*Amsinckia intermedia*	OP	CP	TA		WI		
†*Amsinckia tessellata*	OP	CP	TA		WI		
†*Cryptantha barbigera*	OP	CP	TA		WI		
Cryptantha ganderi		CP			WI		
†*Cryptantha maritima*	OP	CP	TA		WI		
†*Cryptantha pterocarya*	OP	CP	TA		WI		
††*Cryptantha utahensis*			(TA)		(WI)		
Eremocarya micrantha		CP			WI		
Eucrypta chrysanthemifolia	OP	CP			WI		
Eucrypta micrantha	OP	CP	TA		WI		
Harpagonella palmeri	OP				WI		
Heliotropium curassavicum	OP	CP					PR
Johnstonella angustifolia	OP	CP	TA		WI		
Johnstonella holoptera		CP				AP	
†*Johnstonella racemosa*		CP	TA			AP	
†*Lappula occidentalis*	OP	CP			WI		
Nama demissum		CP	TA		WI		
Nama hispidum	OP	CP	TA		WI		
†*Pectocarya heterocarpa*	OP	CP	TA		WI		
†*Pectocarya platycarpa*	OP	CP			WI		
Pectocarya recurvata	OP	CP			WI		
Phacelia affinis	OP				WI		
Phacelia bombycina		CP			WI		
Phacelia coerulea	OP	CP			WI		
†*Phacelia crenulata*	OP	CP	TA		WI		
Phacelia distans	OP	CP			WI		
Phacelia neglecta	OP	CP	TA		WI		
Phacelia pedicellata	OP	CP	TA		WI		
Phacelia ramosissima	OP						PR
Phacelia rotundifolia	OP				WI		
Pholistoma auritum	OP	CP			WI		
†*Plagiobothrys arizonicus*	OP				WI		
Plagiobothrys jonesii	OP				WI		
Tiquilia canescens	OP	CP					PR
Tiquilia palmeri		CP	TA				PR
Totals for Boraginaceae:	**27**	**28**	**16**	**0**	**28**	**2**	**4**

BERBERIDACEAE – Barberry Family

Worldwide, mostly north temperate; 15 genera with 650 species.

Berberis – Barberry

The two species in the flora area are woody shrubs with rigid branches and bright yellow inner bark and wood. Mostly evergreen; leaves with prominent petioles, odd pinnate or 3-foliolate, the leaflets firm with large, spine-tipped teeth. Inflorescences (those in the flora area) of small, few-flowered racemes, the flowers bright yellow to yellow-orange, small, and 3-merous with 9 sepals in 3 whorls (the 3 outer ones also known as bracteoles) and 6 petals in 2 whorls, the petals nectiferous. Stamens 6, tactile (closing inward when touched), the anthers opening by 2 apical valves. Fruits of few-seeded berries, juicy and edible.

Shrubs of the two species occur at higher elevations in the Ajo Mountains, and in some parts of Alamo Canyon they grow next to each other.

This genus is nearly worldwide with 500 species, with very few in deserts.

1. Leaflets mostly 5 or 7, conspicuously glaucous; berries reddish at maturity. ..... **Berberis haematocarpa**
1. Leaflets 3, not glaucous; berries blue-black at maturity..... **Berberis harrisoniana**

Berberis haematocarpa Wooton
[*Mahonia haematocarpa* (Wooton) Fedde]
Red barberry. Figure 2.

Shrubs 1–2.5 m tall; bark rough and fissured. Leaves mostly evergreen, 4–10+ cm long, the leaflets (3) 5 or 7 (9), bluish glaucous, the terminal leaflet longest and often stalked. Sepals yellow, the petals yellow-orange. Berries 6–8 mm in diameter, reddish purple. Flowering winter and early spring, the fruits ripe in April.

Common at higher elevations in the Ajo Mountains, and present in these mountains for more than 13,500 years. The nearest population is isolated on Sierra Pinacate above 800 m.

Arizona to western Texas, southeastern California, southern Nevada, Colorado, and northern Sonora and Chihuahua; often in oak woodland and chaparral.

OP: Alamo Canyon: 18 Dec 1939, *Harbison 26268* (SD); 9 Mar 1946, *Goodding A-13-46*; upper reaches of canyon, sepals light yellow-green, petals orange, 30 Mar 1988, *Baker 7600* (ASU). Arch Canyon, 3500 ft, 28 Mar 1965, *Niles 536*. †Montezuma's Head, leaflets, seeds, 13,500 ybp.

Berberis harrisoniana Kearney & Peebles
Kofa Mountain barberry. Figure 3.

Shrubs to 3 m tall. Leaves mostly evergreen, 4–11.5 cm long, the leaflets 3, sessile, all alike or the terminal one largest, green to yellow-green, not glaucous; leaflets including the margins and spines are thicker than those of *B. haematocarpa*. Flowers apparently monochromatic, yellow to apparently darker (yellow-orange) with age. Berries 5–6 mm in diameter, bluish black. Flowering January and February (March), the fruiting March and April (May).

Ajo Mountains; canyons and cliff bases at higher elevations. It has been in the Ajo Mountains for at least 9600 years.

Documented otherwise from only three other isolated desert ranges: the Sand Tank Mountains in Maricopa County, the Kofa Mountains in Yuma County, and southeastern California in the Whipple Mountains. "Typical habitat is talus slopes and among bases of sheer cliffs, and canyons between 760 and 1100 m. These microsites are generally shady with northern exposure and more mesic than the surrounding desert. ... [It] is a relict species related to *B. trifoliolata* Moricand from southeastern Arizona, New Mexico, and Texas" (Anderson & De Groot 2004: 395; also see Arizona Rare Plant Committee 2001).

OP: Pitahaya Canyon, 3400 ft, *Nichol* 23 Feb 1939. Above Pitahaya Canyon, mesic area above base of W face of Montezuma's Head, 3400 ft, 16 Jan 1976, *Phillips 76-2*. Arch Canyon: S of arch, 3400 ft, deep shaded canyon, wide crack in N facing cliff, 18 Feb 1978, *Fay 738*; Shrub to 3 m, mostly shaded by east-facing steep slopes, 950–1000 m, 12 May 1988, *Baker 7611* (ASU, ORPI). Trail from Bull Pasture to crestline, above The Cones, 32°00.84'N, 112°41.06'W (NAD 27), 4025 ft, 9 Apr 2005, *Felger* (observation). †Alamo Canyon, leaf fragments, seeds, 9570 ybp (very common).

Figure 2. *Berberis haematocarpa*. Middle fork of Alamo Canyon, 24 Mar 2008.

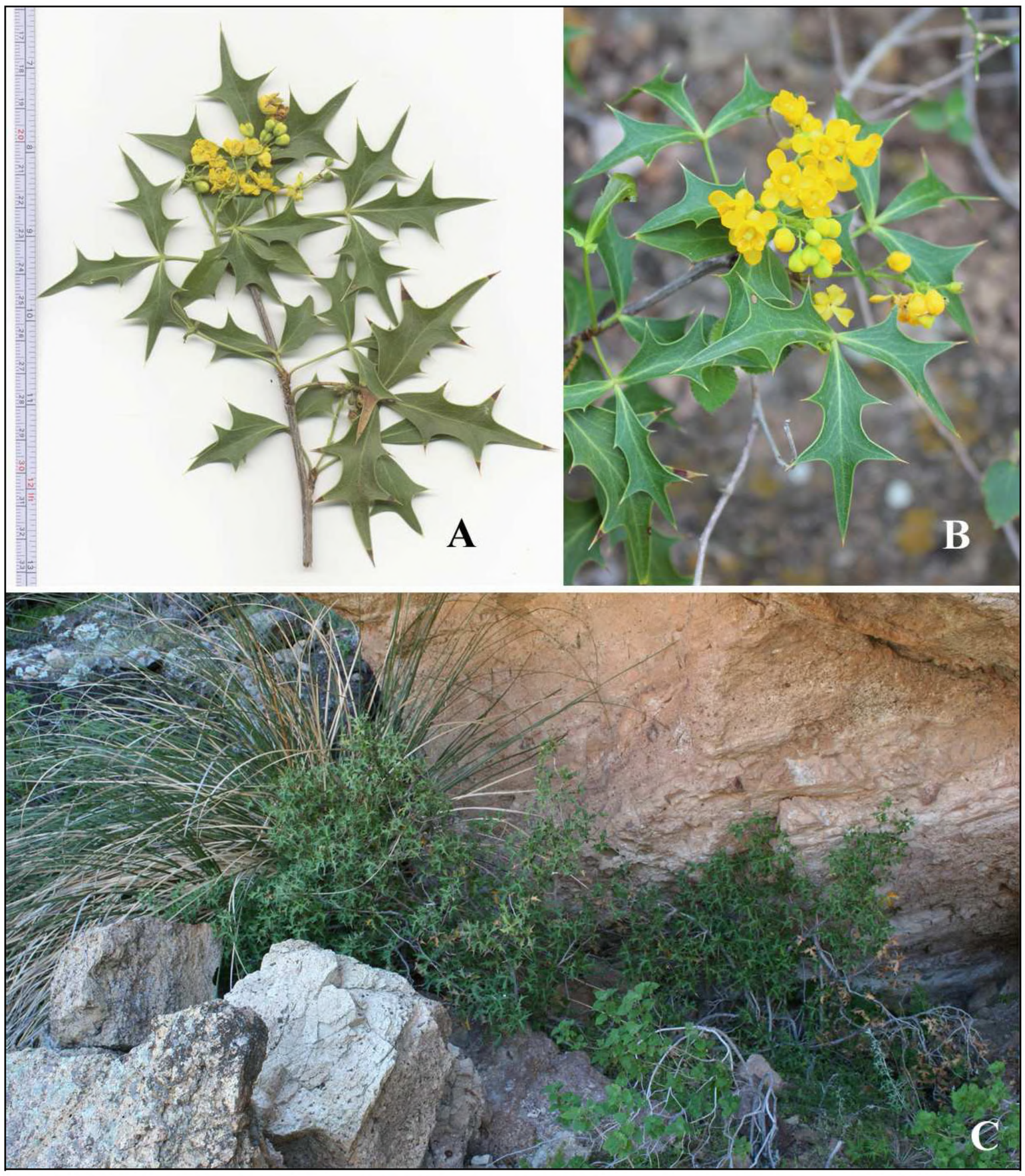

Figure 3. *Berberis harrisoniana.* Estes Canyon, trail to Bull Pasture: (A & B) 30 Jan 2014; (C) note the two shrubs at base of cliff, 10 Apr 2005.

†**Berberis** sp.

Ice Age midden samples from the Ajo Mountains, not identifiable to species, are probably one or both of the present-day species. Some barberries occur today near all of the midden sites.

OP: †Alamo Canyon, leaflet fragments, seeds, 8130 to 29,110 ybp (4 samples). Montezuma's Head, leaflet fragments, seeds, 17,830 to 21,840 ybp (3 samples).

BIGNONIACEAE – Bignonia Family

This family of about 120 genera and more than 700 species is worldwide, mostly in the tropics and subtropics with relatively few in deserts. *Chilopsis* has a single species.

Chilopsis linearis (Cavanilles) Sweet subsp. **arcuata** (Fosberg) Henrickson
Desert willow; *mimbre*. Figure 4.

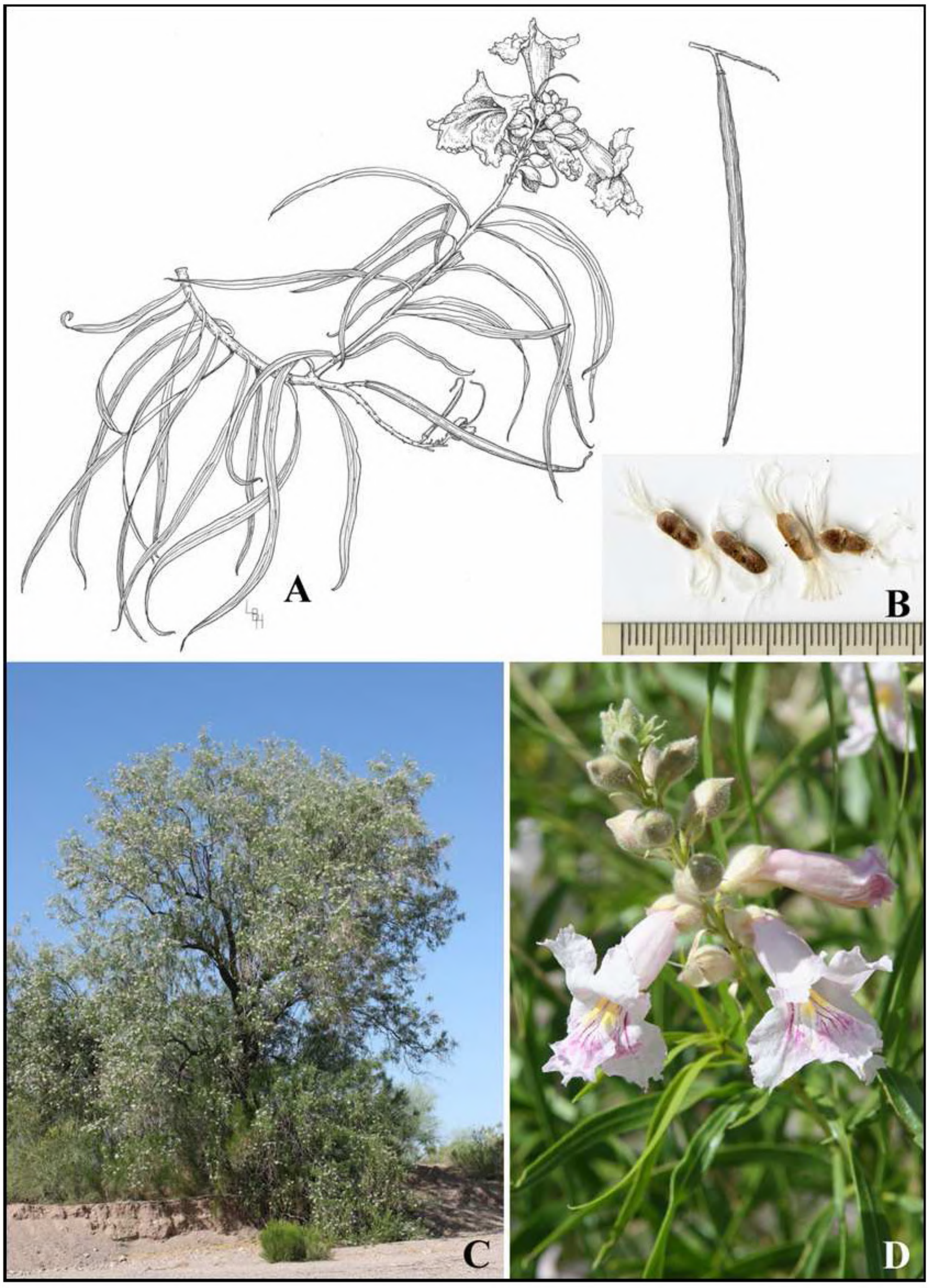

Figure 4. *Chilopsis linearis* subsp. *arcuata*. (A) By Lucretia Breazeale Hamilton. Gunsight Wash near Hwy 85: (B) Seeds, 1 Aug 2014; (C & D) 7 May 2006.

Large, hardwood shrubs or trees to 8 (10) m tall, the trunks seldom straight. Twigs and leaves glandular-viscid: large, sessile glands on the leaves and internodes of young twigs eventually rupture, leaving glandular dot-like areas and coating the surfaces with viscid exudate, functioning as

extrafloral nectaries (Elias 1983; Henrickson 1985). These glands, however, do not break down at the nodes, where they likewise seem to function as extrafloral nectaries (Henrickson 1985). (Desert willow extrafloral nectaries seem to function largely at night, attracting mutualistic ants as well as ant-parasitoid wasps; Carrey et al. 2012). Leaves slender and often 6–20 cm long, drooping, and winter deciduous. Corollas 3–5 cm long, sweet scented, whitish to pale pink, streaked and mottled with purple and yellow nectar guide lines. Flowering April to August but especially in spring. Fruits of slender capsules 13–25 cm long and 0.5 cm wide, filled with flat, papery seeds with tufts of white hairs at each end.

Large washes in the northeastern part of Cabeza Prieta and the northern part of Organ Pipe, e.g., Kuakatch Wash to Growler Wash. In Kuakatch Wash it grows with blue palo verde, white-thorn acacia, desert hackberry, ironwood, and velvet mesquite in the sparse gallery of trees and shrubs lining the wash. In November 2001 the new growth on many of these desert willows was deformed with a "witches'-broom" apparently caused by mites.

This subspecies occurs in northern Sonora and Baja California to southeastern California, southwestern Utah, Arizona, and western New Mexico. Subspecies *linearis* occurs farther east in New Mexico, western Texas, and north-central Mexico southward to San Luis Potosí, and the southeasternmost population in Mexico is described as var. *tomenticaulis* (Henrickson 1985). This variety has dark rose-pink or purplish flowers, and is favored by the horticultural trade and widely planted in the Southwest including at Ajo; hybridization with native desert willow populations is a potential concern. "Fruitless" and lower-fruiting and other horticultural selections have been patented (e.g., Mountain States Nursery 2014). Desert willows can be clonally propagated by cuttings.

The flowers and slender fruits were eaten as a minor food by the Cahuillas (Bean & Saubel 1972). The tough, somewhat woody fruits, however, hardly seem edible. The Cahuillas and others used the strong and flexible wood and branches for bows, house construction, and other practical purposes including the bark or smaller branches for weaving material, nets, and in basketry (Bean & Saubel 1972; Moerman 1998).

OP: Along washes S of Walls Well, 31 Oct 1943, *Clark 11157* (ORPI). Growler Wash near Bates Well Road, 8 Oct 2006, *Rutman 2006-1008-13*.

CP: Daniels Arroyo at Charlie Bell Road, 12 Jun 1992, common along margin of wash, *Felger 92-547*. Growler Wash at Organ Pipe boundary, on both sides of the boundary, 12 Jun 1992, *Felger* (observation).

BORAGINACEAE – Borage Family

Annual (ephemeral) or perennial herbs (those in the flora area); many with rather harsh calcified or silicified (glassy) hairs, others with soft hairs, or glabrous. Leaves mostly alternate, the lower leaves sometimes opposite; first leaves of many species form a basal rosette; stipules none. Inflorescences mostly of circinate scorpioid cymes—coiled to one side distally, straightening as it grows, the flowers on one side; or flowers in small cymose clusters or axillary. Flowers radial (those in the flora area), 4- or 5-merous; calyces and corollas 4- or 5-lobed; stamens epipetalous; ovary 4-lobed in Boraginaceae sensu stricto, not lobed in Hydrophyllaceae. Many temperate and aridland borages (including those in the flora area) have dry fruits that split into 4 or fewer 1-seeded nutlets; those with fewer than 4 nutlets arrive at that condition by abortion of the developing fruit segments or parts. Others have multiple-seeded capsules. (Some borages in other regions have fleshy fruits.) Some borages are quite distinctive, while among others reliable identification often requires looking at small but unique nutlets. All borages, sensu stricto, should be considered poisonous due to the widespread occurrence of hepatotoxic pyrrolizidine alkaloids. Nearly worldwide, ±120 genera, ±2300 species.

We follow APG III (Angiosperm Phylogeny Group 2009), wherein Boraginaceae includes Hydrophyllaceae. Subsequent findings (e.g., Gottschling et al. 2014, Weigand et al. 2013; also see Stevens 2001) would place the genera in southwestern Arizona as follows:

Boraginaceae: *Amsinckia, Cryptantha, Eremocarya, Harpagonella, Johnstonella, Lappula, Pectocarya, Plagiobothrys*
Ehretiaceae: *Tiquilia*
Heliotropiaceae: *Heliotropium*
Hydrophyllaceae: *Eucrypta, Phacelia, Pholistoma*
Unplaced (sister to Cordiaceae, Ehretiaceae + Lennoaceae, and Heliotropiaceae): *Nama*

Boraginaceae in the flora area includes 14 genera with 34 modern species, 10 of which are also represented by fossils, and one fossil (*Cryptantha utahensis*) no longer occurs in the flora area (Table 1). Cool-season ephemerals make up 82% (28 species) of the modern flora, and the two facultative annual/perennials also are cool-season plants. There are no summer-growing ephemerals. The four perennials are herbaceous, and only *Heliotropium* (Ehretiaceae) and *Tiquilia* (Ehretiaceae) are non-seasonal in growth response. Thus, the Boraginaceae (sensu stricto), Hydrophyllaceae (sensu stricto), and *Nama* grow only during the cooler months.

Measurements of corolla width in the keys and descriptions represent the total diameter or width of the corolla limb on both sides of the corolla aperture or throat as well as the aperture itself.

1. Plants glabrous, succulent, and often halophytic ..... **Heliotropium**
1. Plants variously hairy, not succulent and glabrous.

2. Perennials, low-growing and usually long-lived, growing and flowering at various seasons; flowers axillary, single or clustered, essentially sessile; corollas lavender; stigmas 2 and capitate. ..... **Tiquilia**
2. Winter-spring ephemerals; flowers in scorpioid cymes or axillary; corollas lavender or not; or if herbaceous perennials, then the plants not low-growing.

3. Stems square in cross section, weak and scrambling, with hooked hairs on stem angles; calyx with conspicuous auricles (sepal-like appendages between calyx lobes) ..... **Pholistoma**
3. Stems not square, not weak and scrambling, hairs not hooked; calyx without auricles.

4. Plants stinky and markedly glandular-viscid; inflorescence branches tightly coiled to one side distally; fruits of capsules, seeds 4 to many ..... **Phacelia**
4. Herbage not stinky, not markedly viscid (except *Eucrypta*); inflorescences coiled or not; fruits of capsules or 1 to 4 nutlets.

5. Plants with stiff, glassy or conspicuously harsh hairs; corollas white or yellow-orange.

6. Corollas yellow-orange ..... **Amsinckia**
6. Corollas white.

7. Nutlets 2–4 per fruit, without a prominent ventral groove, the attachment scar narrowly triangular to linear or ± round, along an elongated ventral keel or at base of a short ventral keel ..... **Plagiobothrys**
7. Nutlets 1 or 4 per fruit, with an open to closed ventral groove, usually forked or widened near the base, the attachment scar variable in shape, generally recessed, sometimes minute; ventral keel absent
..... **Cryptantha** sensu lato (includes **Eremocarya** and **Johnstonella**)

5. Herbage softer, hairs not harsh; corollas white, bluish, pinkish or lavender.

8. Corollas white or bluish; fruits usually of 4 nutlets (2 in *Harpagonella*), seeds 1 per nutlet.

9. Plants staining reddish when pressed; calyx circumscissile, the calyx and nutlets without spine-like appendages or teeth, the attachment scar located at the base of a central keel ..... **Plagiobothrys arizonicus**
9. Plants not staining reddish; calyx not circumscissile, the calyx and/or some nutlets bearing spine-like appendages or teeth (*Harpagonella* has unornamented nutlets but a spinescent calyx).

10. Calyx bur-like; one pair of calyx lobes fused, accrescent, enclosing 1 or both nutlets, with spine-like appendages on the back; nutlets 2, not toothed (caution: in this couplet, do not confuse calyx lobes with the nutlets)
..... **Harpagonella**
10. Calyx not bur-like; calyx not accrescent and not enclosing nutlets, without spine-like appendages; nutlets usually 4, the margins often toothed.

11. Plants generally erect, the main axis well developed; corollas pale blue or whitish; nutlets held upright, the marginal teeth (spines) barbed ..... **Lappula**
11. Plants often spreading and without a strong main axis; corollas white; nutlets spread open like tiny, open jaws, the marginal teeth not barbed (hooked at tip in *P.anisocarpa)* ..... **Pectocarya**

8. Corollas pinkish, purplish, or white; fruits of capsules with more than 4 seeds.

12. Leaves sessile or the blade tapering into the petiole, the margins entire (sometimes inrolled); corollas pinkish or purplish ..... **Nama**
12. At least the lower leaves petioled, the petiole and blade clearly differentiated, the blades pinnately lobed, or toothed or wavy; corollas whitish, pale violet, or lavender, with a pale yellow throat.

13. Stems slender and delicate, not succulent; leaf blades pinnately lobed; corollas pale violet, or lavender, with a pale yellow throat ..... **Eucrypta**
13. Stems thick, semi-succulent, short and stubby; leaf blades ovate; corollas whitish ..... **Phacelia neglecta**

Amsinckia – Fiddleneck

Winter-spring ephemerals, mostly erect, the herbage with coarse, often bulbous-based hairs. Flowers in scorpioid cymes, coiled to one side distally, the corollas bright yellow-orange (no other Sonoran Desert borages have yellow or orange corollas). Nutlets 4, homomorphic. The two species in the flora area are common and widespread, often growing intermixed along washes, canyons, floodplains, valley bottoms, bajadas, and rocky slopes. There is great variation in ornamentation and sculpturing of the nutlets, which led Wilhelm Suksdorf (1931) to recognize about 235 species of *Amsinckia*, nearly all of them subsequently buried in synonymy.

The genus includes about 14 species; western North America and two species in southwestern South America.

1. Calyx lobes 5, about equal in size; back of nutlets rough with ragged-edged ornamentations, arched with a high dorsal spine-ridge..... **Amsinckia intermedia**
1. Calyx lobes 3 to 5, unequal in size, often 2- or 3-toothed at tip due to fusion of lobes; back of the nutlets enamel-like with smooth-edged bumps (tessellated), not conspicuously arched, the dorsal ridge not raised or only slightly so..... **Amsinckia tessellata**

Amsinckia intermedia Fischer & C.A. Meyer
Devil's lettuce, common fiddleneck; cetkom. Figures 5 & 6.

Plants often 30–50 cm tall, and sometimes to 1 m tall in favorable, seasonally wet places. Calyx lobes all alike. Corolla tube about 10-veined below insertion of the stamens. Nutlets 2.4–2.6 mm long, relatively deep and arched, the dorsal side (back) with a high ridge-crest, sculptured with sharp, ragged surfaces. Plants, inflorescence branches, and hairs often less robust than those of *A. tessellata*; also the inflorescences tend to become more elongated and slender in *A. intermedia*.

Widespread across the flora area in many habitats including valley floors, hills and mountains. This species has been in the Tinajas Altas Region for at least 11,300 years. Widespread in western North America.

There are reports of young plants eaten as greens, cooked or even fresh (Hrdlička 1908 and Russell 1908, as interpreted by Rea 1997). Felger (2007) agreed with Amadeo Rea that these unpleasant, rough-haired plants hardly seem palatable. Suksdorf "recognized over 100 species that fall within" *A. intermedia* (Higgins 1979: 312).

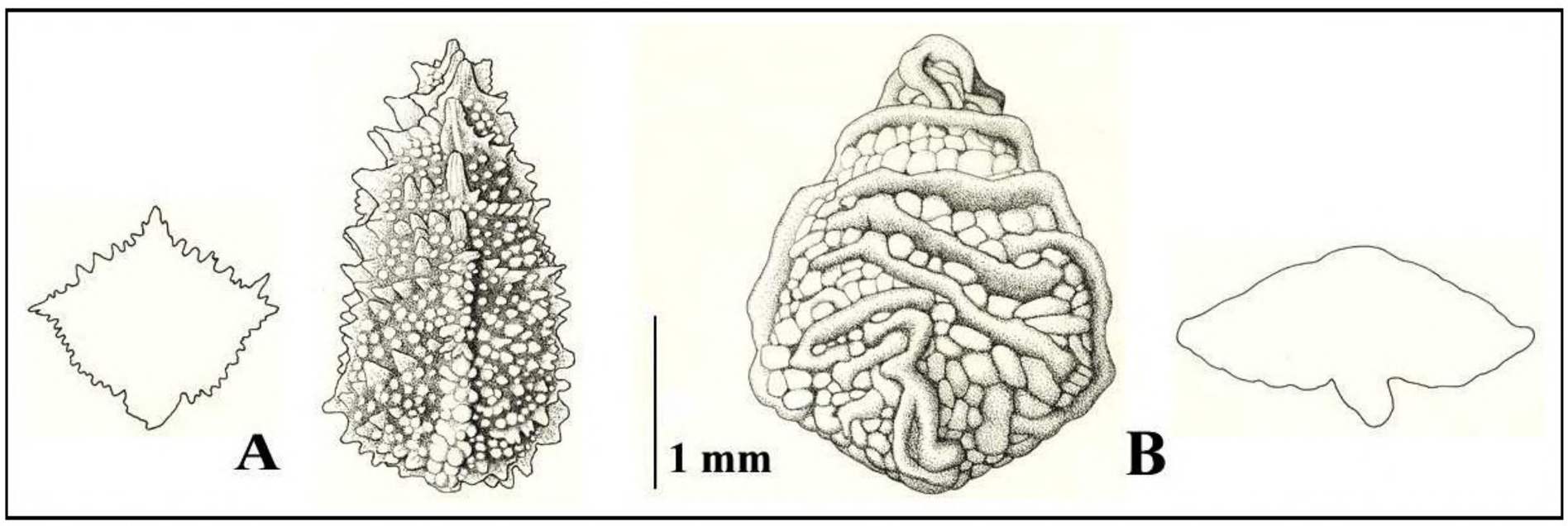

Figure 5. *Amsinckia* nutlets. Cross-sections and dorsal views; from Gran Desierto, NW Sonora, by Matthew B. Johnson: (A) *A. intermedia*; (B) *A. tessellata* var. *tessellata*.

OP: Aguajita Wash, 6 Apr 1988, *Felger 88-305*. 0.6 mi E of Lukeville, 20 Feb 1988, *Felger 88-03*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-279* (ORPI).

CP: Charlie Bell Road just W of ORPI boundary, 25 Jan 1993, *Felger 93-58*.

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Camino del Diablo, S end of Coyote Wash, 28 Mar 2010, *Felger 10-169*. †Butler Mts, nutlet, 11,250 ybp. †Tinajas Altas, nutlet, 9230 ybp.

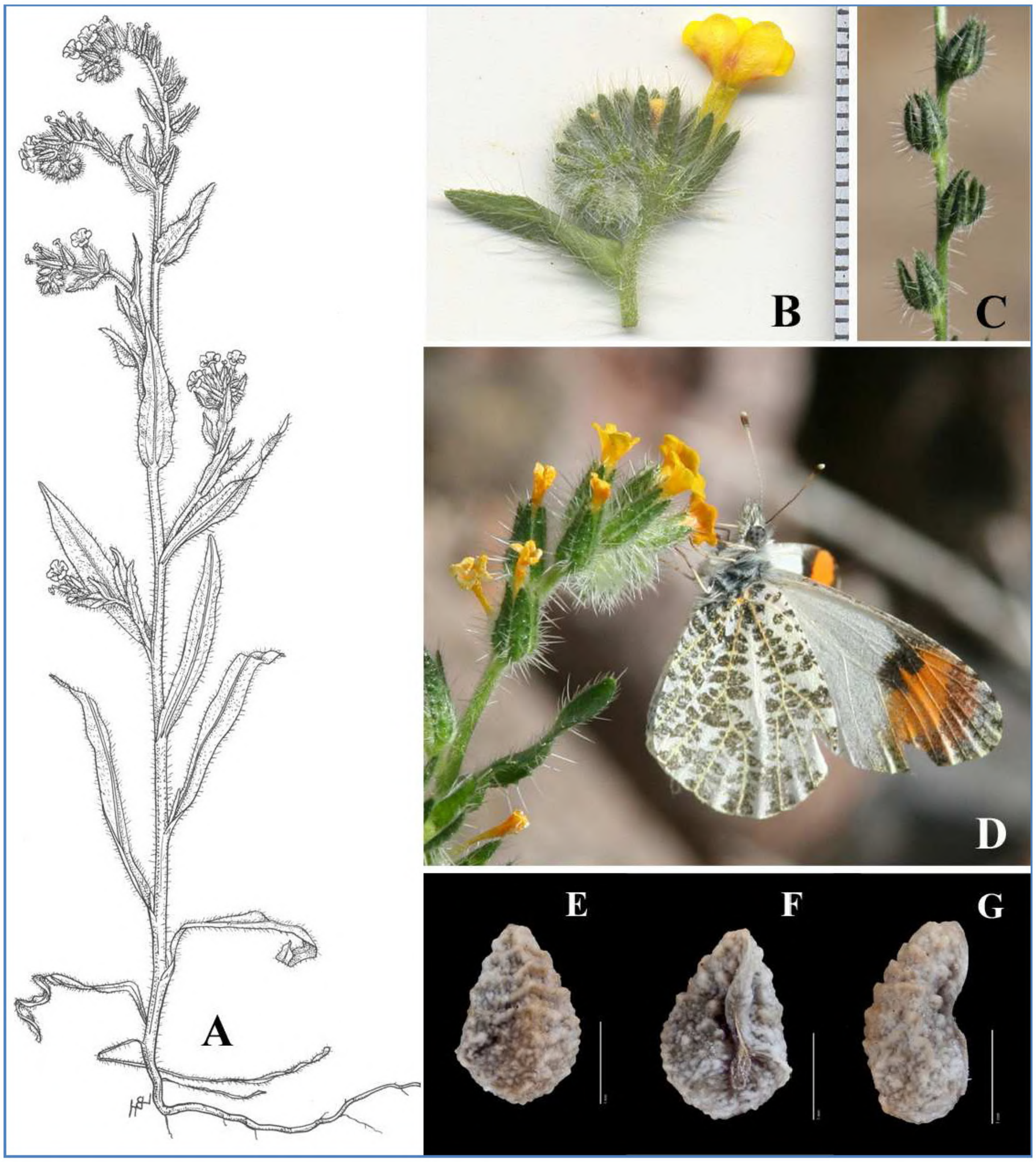

Figure 6. *Amsinckia intermedia*. (A) By Lucretia Breazeale Hamilton. Alamo Canyon: (B) 28 Feb 2009; (D) with southwestern orangetip (*Anthrocharis sarathoosa*), 4 Mar 2009. (C) Kuakatch Wash near Hwy 85, 3 Mar 2014. (E–G) Nutlet, dorsal, ventral, and lateral view, bar = 1 mm; Claremont, CA, 26 Apr 1948, *Gallup 145* (SDSU 4890); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/amsinckia/taxa.html

Amsinckia tessellata A. Gray var. **tessellata**
Checker fiddleneck; cetkom. Figures 5 & 7.

Plants resembling *A. intermedia* but often larger and more robust. Calyx lobes usually unequal with 2 of the lobes united. Corolla tube with about 20 veins below the insertion of the stamens. Nutlets 2.8–3 mm long, the back tessellated with a mosaic of crowded, broad, irregular, and smooth-edged bumps like cobblestone wrinkled by an earthquake, and sometimes with smooth, transverse ridges.

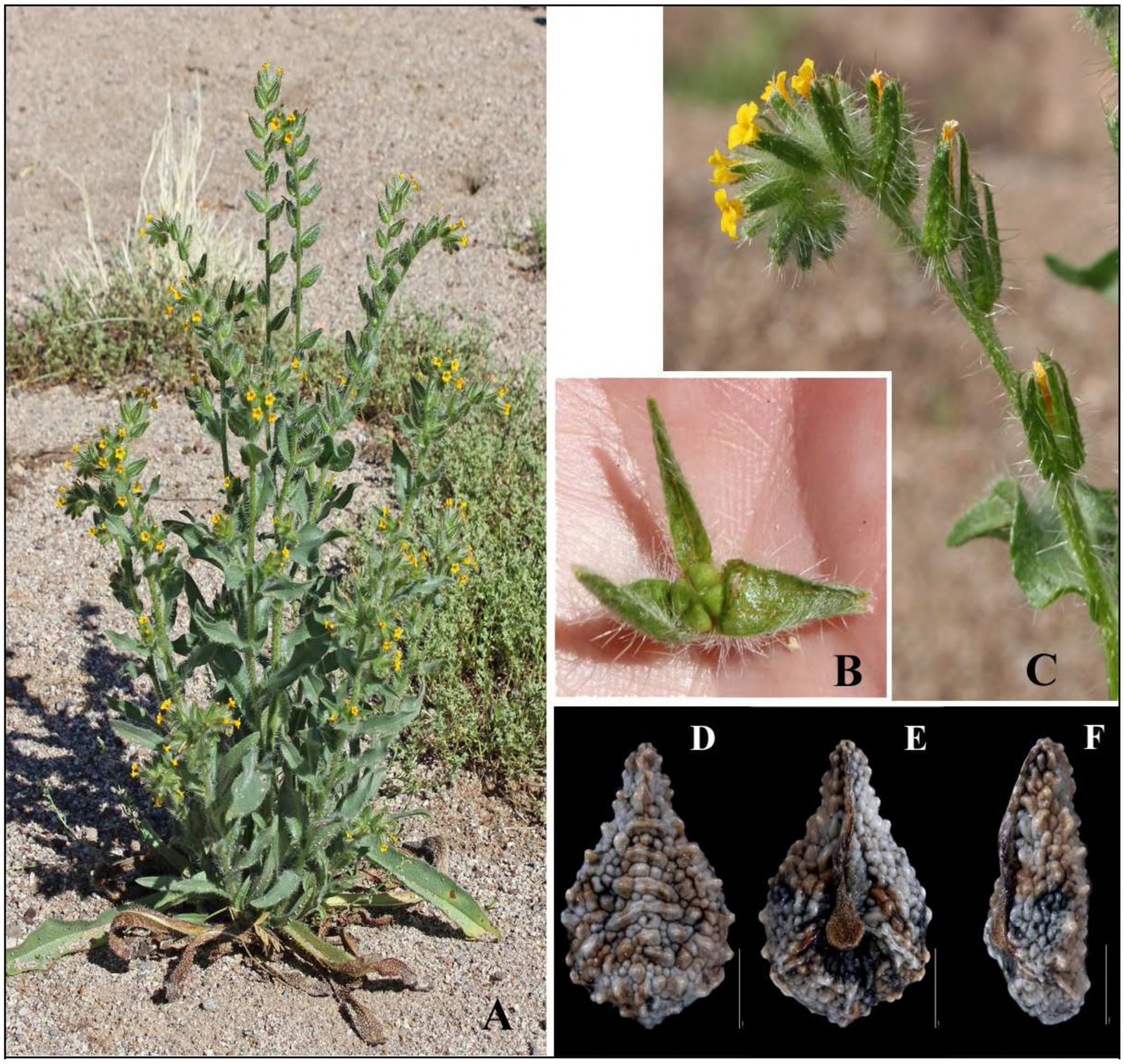

Figure 7. *Amsinckia tessellata* var. *tessellata*. (A) Kuakatch Wash near Hwy 85, 3 Mar 2014. Alamo Wash: (B) sepals and developing nutlets, 11 Mar 2014; (C) 4 Mar 2009. (D–F) Nutlet, dorsal, ventral, and lateral view, bar = 1 mm; Anza-Borrego State Park, San Diego Co., CA, 19 Mar 2005, *Gregory 1327* (SD 173640); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/amsinckia/taxa.html

Widespread in Cabeza Prieta and Organ Pipe, and Tinajas Altas at the west boundary of Cabeza Prieta. Rocky to gravelly, sandy, or cinder soils; slopes, pediments, flats, and arroyo beds. This species has been in the flora area for more than 21,000 years.

Eastern Washington, Idaho, and Utah to Baja California and northern Sonora. An additional variety occurs in California. This species is disjunct in South America.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Bates Well, 22 Apr 1942, *Cooper 727*. Aguajita Wash, *Beale 8 Apr 1988* (ORPI). †Alamo Canyon, nutlets, 21,110 ybp. †Montezuma's Head, nutlets, 17,830 & 20,490 ybp. †Puerto Blanco Mts, nutlets, 9860 ybp.

CP: Jose Juan Tank, 23 Feb 1993, *Felger 93-104*. Buckhorn Tank, 27 Feb 1993, *Felger 93-181*. Camino del Diablo at W boundary of Refuge, 27 Feb 1993, *Felger 93-197*.

TA: Camino del Diablo at E boundary of Tinajas Altas Region, 28 Mar 2010, *Felger 10-161*. †Butler Mts, nutlets, 10,360 ybp. †Tinajas Altas, nutlets, 9230 to 15,050 ybp (3 samples).

Cryptantha sensu lato

Winter-spring ephemerals plus two perennial species (*Johnstonella holoptera* and *J. racemosa*) growing and flowering only during the cooler seasons; with glassy or coarse hairs. Leaves slender and sessile. Flowers in scorpioid cymes, coiled to one side distally, or sometimes not evidently coiled or only slightly so. Flowers small and white (those in the flora area). Fruits with 1–4 nutlets enclosed in a calyx covered with harsh, glassy or coarse hairs. Nutlets often dissimilar (heteromorphic) in size and ornamentation, and how readily they fall out of the calyx, or all similar (homomorphic) (Figure 8). The different nutlets morphologies including sizes (weights) can lead to different strategies for dispersal and establishment (e.g., Felger 2000). In the classical sense, *Cryptantha* sensu lato includes 150 species in North America, especially the western part, and in Andean South America.

Hasenstab-Lehman and Simpson (2012) show that *Cryptantha* in the broad sense is not monophyletic, and those in the Sonoran Desert are best classified into three genera: *Cryptantha*, *Eremocarya*, and *Johnstonella*.

Key to the species of *Cryptantha* sensu lato

1. Nutlet margins sharp-edged, knife-like, or winged.

2. Nutlet margins knife-edged but not winged; inner face of nutlet flat; back of nutlet smooth and markedly convex. ..... **Johnstonella costata**
2. Nutlet margins winged (very narrowly so in *J. racemosa*); inner nutlet face not flat; back of nutlet studded with bumps.

3. Ephemerals; calyx broad (lobes ovate to lance-ovate); wing of nutlet usually as wide as body and fringed with finger-like projections. ..... **Cryptantha pterocarya**
3. Ephemerals to perennials; calyx narrow (lobes lanceolate); wing of nutlet narrower than the body and entire.

4. Bark not peeling away or only moderately exfoliating with age; nutlets similar in size, the margin with a ribbon-like wing. ..... **Johnstonella holoptera**
4. Bark conspicuously peeling away; nutlets dissimilar in size, the margin with a very narrow bead-like wing. ..... **Johnstonella racemosa**

1. Nutlet margins rounded or angled but not knife-edged or winged.

5. Inflorescences strongly coiled to one side distally; flowers without bracts between (subtending) them.

6. Plants often about as wide as tall, branching from near base; flowers crowded in inflorescence; nutlets within a fruit dissimilar (heteromorphic), 4 per fruit, nutlet toward inflorescence axis larger than the other 3. ..... **Johnstonella angustifolia**
6. Plants often taller than wide; flowers often not crowded in inflorescence; nutlets 1 or if 3 or 4 then all of the same size and similar within a fruit (homomorphic).

7. Nutlets rough (tuberculate), (1) 4 per fruit..... **Cryptantha barbigera**
7. Nutlets smooth, 1 (occasionally 2) per fruit. ..... **Cryptantha ganderi**

5. Inflorescences not prominently coiled to one side distally; bracts beneath (subtending) at least some flowers.

8. Stems not unusually slender, not wire-like; dye in roots and stems not conspicuous; bracts few; nutlets 1..... **Cryptantha maritima**
8. Stems markedly slender, wire-like; roots and stems with copious purple dye; each flower subtended by a leaf-like bract; nutlets 4..... **Eremocarya micrantha**

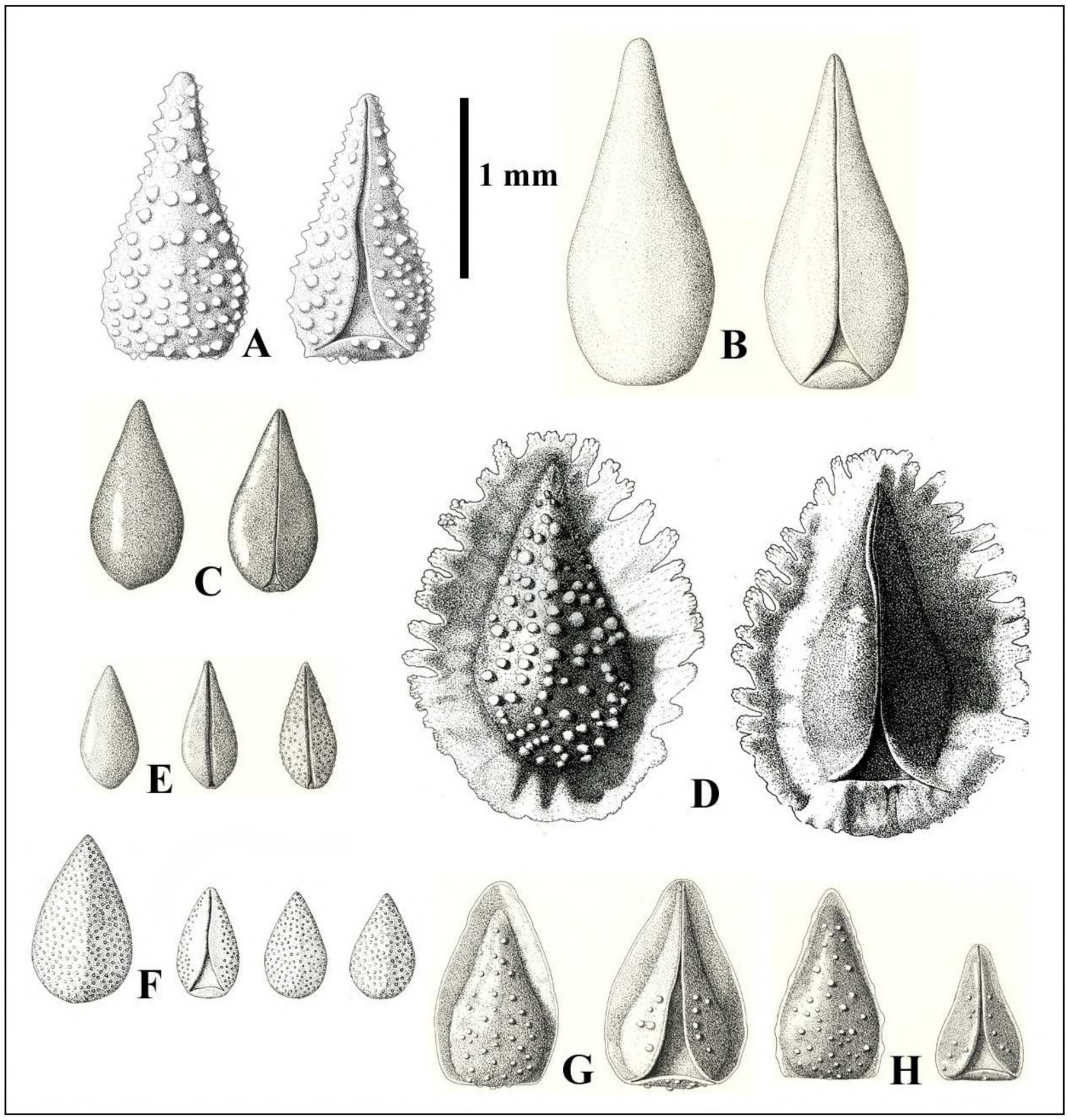

Figure 8. Nutlets of *Cryptantha, Eremocarya, and Johnstonella*. (A) *Cryptantha barbigera* var. *barbigera*; (B) *C. ganderi*; (C) *C. maritima*; (D) *C. pterocarya* var. *cycloptera*; (E) *Eremocarya micrantha*; (F) *Johnstonella angustifolia*; (G) *J. holoptera*; (H) *J. racemosa*; by Matthew B. Johnson (from Felger 2000).

Cryptantha

Annuals in North America (cool-season ephemerals in the Sonoran Desert), mostly the western part, 55 species; and 68 species in Andean South America, including two also in North America (amphitropical species) (www.sci.sdsu.edu/plants/cryptantha/).

Cryptantha barbigera (A. Gray) Greene var. **barbigera**
Bearded cryptantha, bearded cat's eye. Figures 8A & 9.

Plants often 15–55 cm tall, the inflorescences open and loose with several long branches, or the plants sometimes only 3–6+ cm tall when water stressed. Larger leaves often 3–17 × 0.4–1.4 cm, linear to lanceolate, the apex obtuse; often not forming a basal rosette. Inflorescences prominently coiled distally. Calyx, especially basally, with long, white hairs (hence the specific and common names). Corollas often 4 mm wide. Nutlets (1.7) 1.8–2.2 mm long, (1–3) 4 per fruit, homomorphic, the surfaces brown to gray with prominently raised bumps (tuberculations) throughout, the margins rounded, the inner face not flat, the ventral groove and nutlet itself slightly crooked. The plants sometimes sterile with abnormal growth apparently caused by infestations of mites.

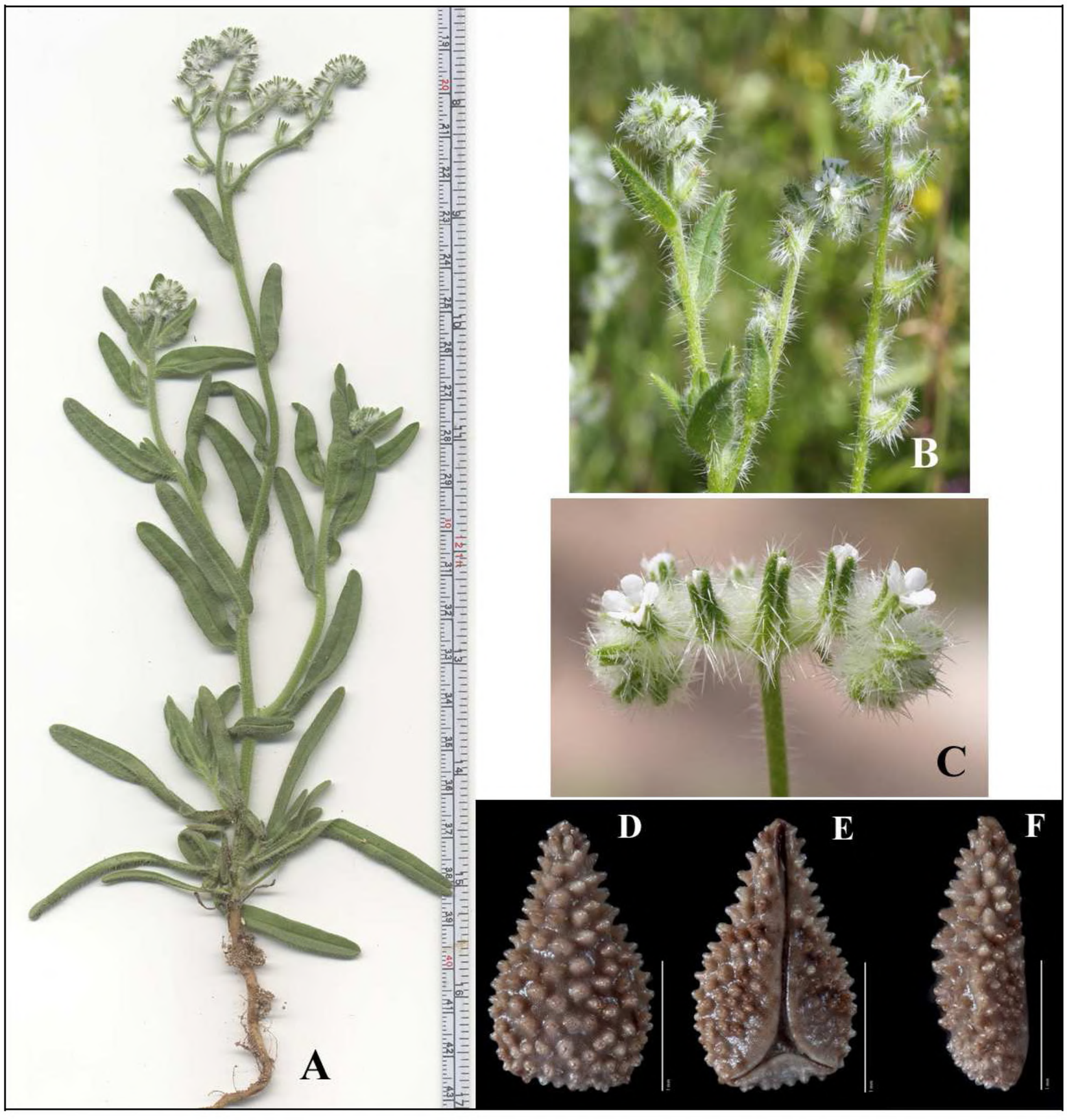

Figure 9. *Cryptantha barbigera* var. *barbigera*. (A) Alamo Wash near Hwy 85, 5 Mar 2014. (B) Chico Shunie area, 26 Feb 2005. (C) Victoria Mine, Puerto Blanco Mts, 1 Apr 2010. (D–F) Nutlet, dorsal, ventral, and lateral views, bar = 1 mm; Anza-Borrego State Park, San Diego Co., CA, 6 Jun 1991, *Simpson 6V19AD* (SDSU 5378); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_barbigera/v_b/

Widespread across the flora area in many habitats; sandy soils of washes and plains, and on rocky slopes to higher elevations. It has been in the flora area for at least 13,500 years.

Variety *barbigera* ranges from southeastern California to southwestern Utah, Arizona, southern New Mexico, west Texas, Baja California, and northern Sonora. *Cryptantha barbigera* var. *barbigera* from Arizona and farther east has a distinctive appearance, being more slender with slightly larger corollas than Californian populations, however the bearded calyx is a constant feature (Ronald B. Kelley, pers. comm. to R. Felger, 2014). Another variety, *C. barbigera* var. *fergusoniae* J.F. Macbride, occurs in the California deserts.

OP: Puerto Blanco Mts, *Nichol 25 Feb 1939*. Alamo Canyon, 12 Apr 1978, *Bowers 1249*. 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1595*. Aguajita, 23 Oct 1987, *Felger 87-260*. Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-288*. †Montezuma's Head, nutlets, 13,500 ybp. †Puerto Blanco Mts, nutlets, 9070 ybp.

CP: Tule Mts, 23 Mar 1935, *Kearney 10880*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3943* (CAB). Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-273*.

TA: Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger 98-137*. †Tinajas Altas, nutlets, 5080 ybp.

Cryptantha ganderi I.M. Johnston
Dune cryptantha. Figures 8B & 10.

Plants often 10–30 cm tall, vegetatively similar to *C. barbigera* but usually with somewhat smaller, narrower leaves and more rigid stems. Larger leaves 4.5–8 cm × 2.2–5 mm, not in a basal rosette. Inflorescences prominently coiled distally. Corollas pure white, 2.8–3.5 mm wide. Nutlets 2.6–2.9 mm long, smooth, 1 (2) per fruit (ovules or immature nutlets rarely 3).

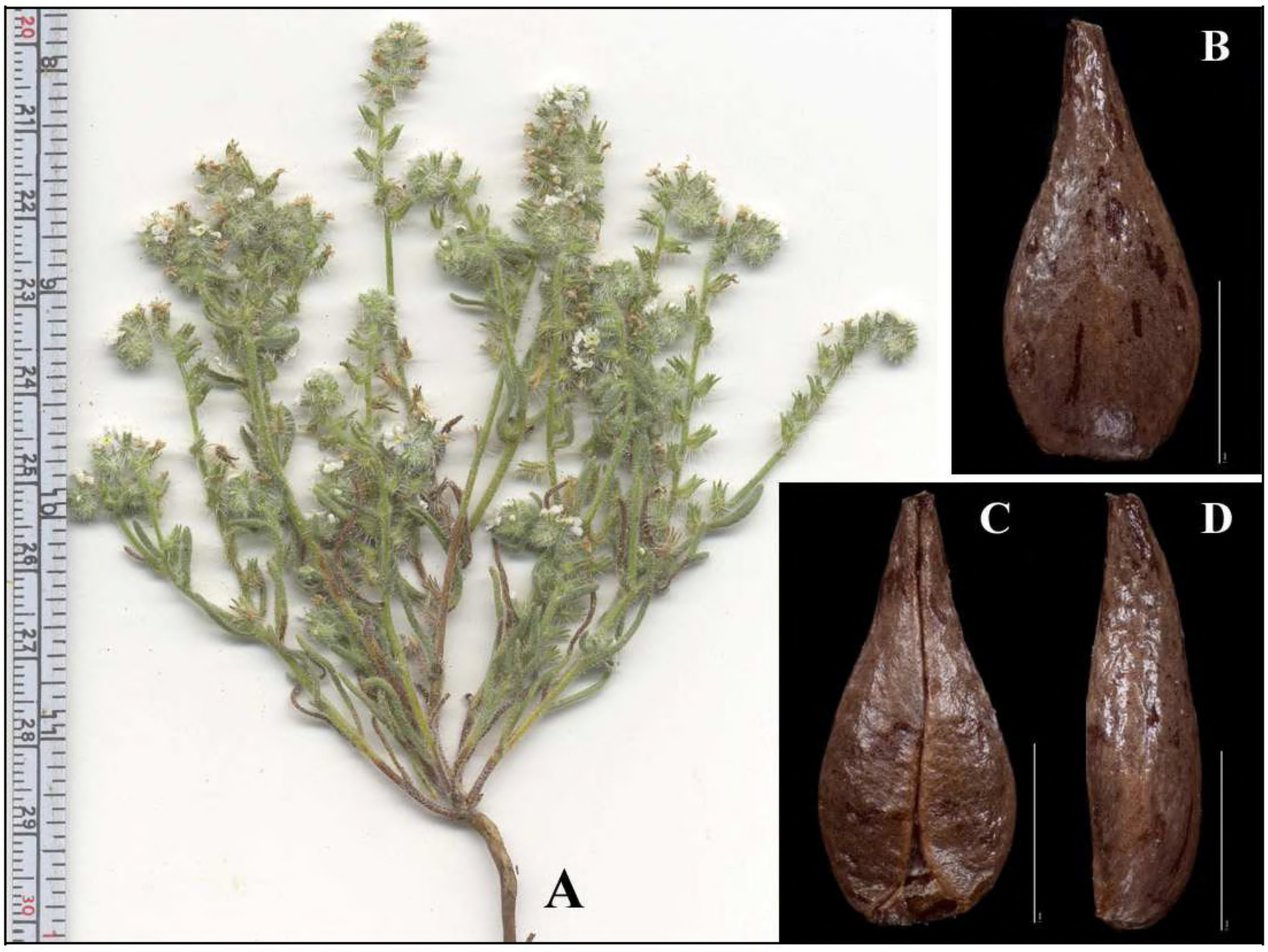

Figure 10. *Cryptantha ganderi*. (A) Dunes, Mex Hwy 2 through Gran Desierto, W of Tule Mts, Sonora, 5 Mar 2014. (B–D) Nutlet, dorsal, ventral, and lateral views, bar = 1 mm; San Diego Co., CA, 19 Mar 1983, *Armstrong 252* (SD 115050); by Michael G. Simpson, and students, <http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_ganderi/>

Locally the most common cryptantha on dunes and sand flats of the Pinta Sands, often growing with *Eremocarya micrantha* and *Johnstonella angustifolia*. Common in sand soils of northwestern Sonora, and in Arizona known only from the Pinta Sands and Mohawk Dunes. Also localized in sand soils in NE Baja California and in SE California. It was not confirmed for Arizona until 1993 (Felger et al. 1993).

Cryptantha ganderi is a dune and sand endemic perhaps related to *C. barbigera*. Hasenstab-Lehman and Simpson (2012) show that it is closely related to *C. intermedia*, which shows similarities to *C. barbigera*. The vegetative plants might be confused with those of *C. barbigera*; *C. ganderi* nutlets are similar in shape to those of *C. barbigera* but larger, smooth and slightly more slender, the ventral groove narrower and straight (rather than crooked), and the sinus at the base of the groove smaller. Also *C. ganderi* usually has only 1 nutlet whereas *C. barbigera* has 1 to 4.

CP: Dunes S of E side of Pinacate lava flow–Camino del Diablo junction, 21 Mar 1992, *Harlan 90* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-388*.

Cryptantha maritima (Greene) Greene var. **maritima**
[C. *maritima* var. *pilosa* I.M. Johnston]
White-haired cryptantha. Figures 8C & 11.

Plants highly variable in size, often with an erect main axis and branching mostly above the middle. Stems dark brown to red-brown, foliage often dark green, the dead, dark brown leaves persisting on stems. Inflorescence branches short, reaching 2 (3.5) cm, scorpioid cymes only slightly coiled at the tips, appearing racemose. Corollas 0.5–1.5 mm wide. Fruiting calyx slender, with relatively large glassy hairs, and much longer than the enclosed nutlet. Nutlets 1.2–1.5 mm long, smooth, shiny, dark red-brown, slender, 1 per fruit. As with *C. barbigera*, the plants are sometimes deformed, apparently due to mite infestations.

Common throughout the flora area in many habitats; washes and sand flats to rocky slopes often to their peaks. This species has been in the flora area for more than 11,000 years.

Western and southern Arizona, southern Nevada, southern California, both Baja California states, and Sonora south to the Guaymas region, and disjunct in South America.

Variety *pilosa* does not seem worthy of recognition; it often occurs freely intermixed and intergrades with var. *maritima* (Felger 2000; Simpson & Hasenstab 2009). Variety *maritima* has 2 ovules and 1 or 2 nutlets, although all specimens seen in the flora area and adjacent northwestern Sonora have 1 nutlet; plants in California often have 2 nutlets, one smooth and one tuberculate. The distinctive *C. maritima* var. *cedrosensis* (Greene) I.M Johnston on Isla Cedros off the coast of Baja California has 4 ovules and 1–4 nutlets.

OP: Quitobaquito, 18 Mar 1945, *Gould 3005*. Sierra de Santa Rosa, 11 Feb 1978, *Bowers 1032*. SE of Dripping Springs, 29 Jan 1986, *Phillips 86-6* (ORPI). Aguajita Wash, *6 Apr 1988, Felger 88-269*. †Puerto Blanco Mts, calyces, nutlets, 9070 & 9720 ybp. †Montezuma's Head: fruits with calyces and nutlets (1 per fruit, smooth, 1.8 mm long), 20,490 ybp; fruits with calyces, nutlets (1 per fruit, smooth), 21,840 ybp.

CP: Tule Tank, *Goodding 6 Mar 1940* (ASU). 8 mi E of Papago Well, Agua Dulce Mts, 14 Apr 1941, *Benson 10758*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3916* (CAB). Cabeza Prieta Peak, summit, 24 Mar 1995, *Yeatts 3660* (CAB).

TA: Tinajas Altas, 23 Mar 1935, *Kearney 10905*. †Butler Mts, calyx, nutlets, 740 to 10,360 ybp (3 samples). †Tinajas Altas, fruits, nutlets, 4010 to 11,040 ybp (8 samples).

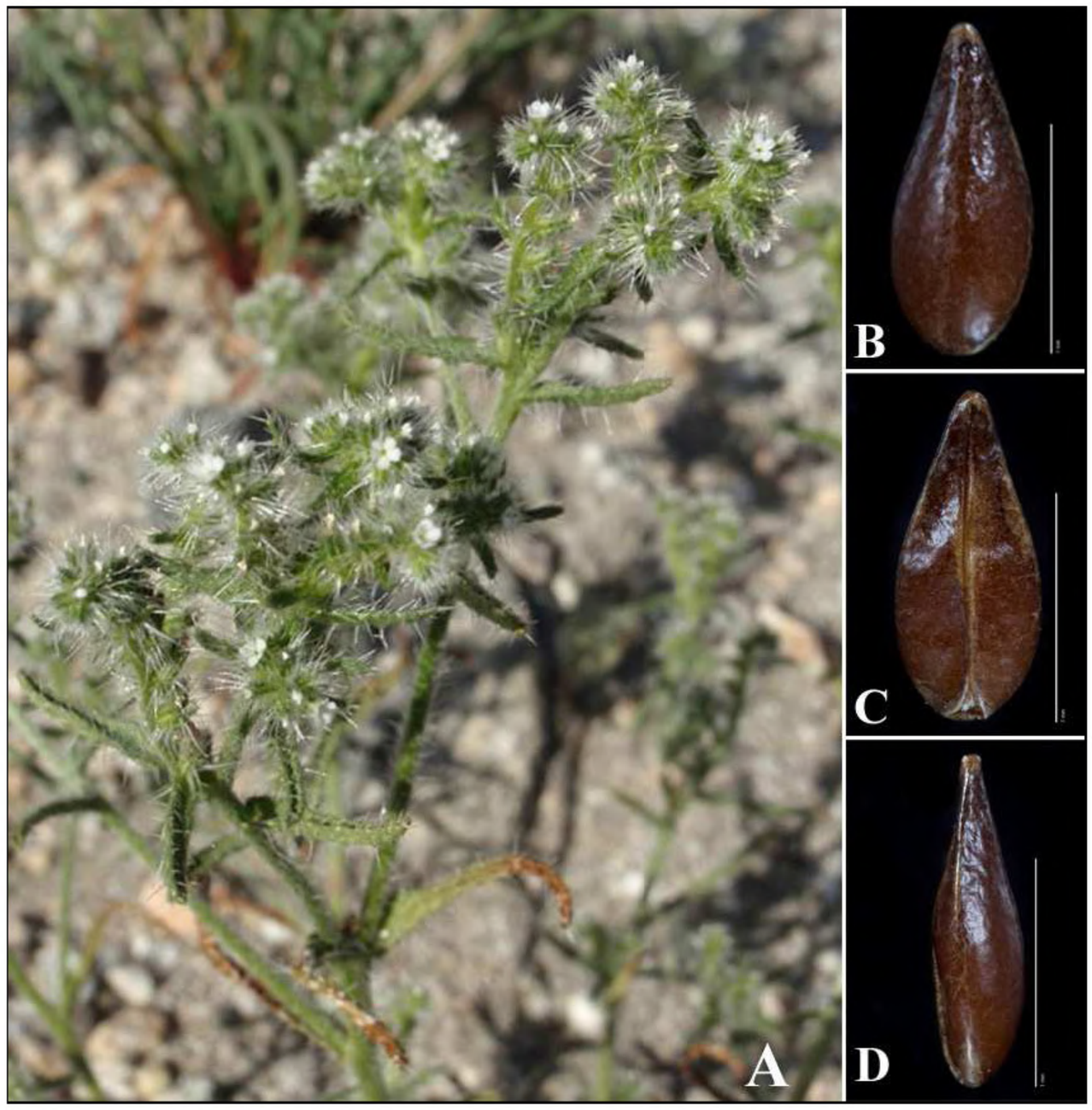

Figure 11. *Cryptantha maritima* var. *maritima*. (A) Desert Hot Springs, Riverside Co., CA, photo by Max Licher (SEINet). (B–D) Nutlet, dorsal, ventral, and lateral views, bar = 1 mm; E shore of San Ignacio Lagoon, Baja California Sur, 26 Mar 1974, *Moran 21176* (SD 86945); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_maritima/C_maritima_v_m/

Cryptantha pterocarya (Torrey) Greene var. **cycloptera** (Greene) J.F. Macbride
Wing-nut cryptantha, fringe-nut cryptantha. Figures 8D & 12.

Plants erect and unbranched, or with mostly few, ascending branches. Inflorescences appearing racemose, only slightly coiled distally on larger plants. Calyx appearing angled due to thickened midribs of calyx lobes, these broadly ovate, obtuse, and bright green, becoming tan, and enlarging to 4.5–6 mm long as the fruit matures. Corollas 1–1.5 mm wide. Nutlets homomorphic, 2.5–3 mm long, 4 per fruit, intricately sculptured, the body studded with blunt tubercles and edged by a broad, light-colored wing edged with blunt, finger-like projections, the wings often bent as they grow crammed in the calyx, the wings and body the color of milk chocolate speckled with darker blotches. (In occasional water-stressed plants the wing-margin of the odd nutlet is much narrowed but not wingless.) This *Cryptantha* is readily recognized by the relatively large fruits and broad sepals, green when fresh and only moderately hairy, and relatively large nutlets with broad, ornamented wings.

Common throughout the flora area in many habitats including desert flats, washes, canyons, bajadas, and rocky slopes often to their summits. Its history in the flora extends to at least 22,000 years.

Variety *cycloptera* is widespread in Sonora, both Baja California states to Washington and Utah, and eastward to New Mexico and western Texas. Two other varieties in western United States and northwestern Mexico.

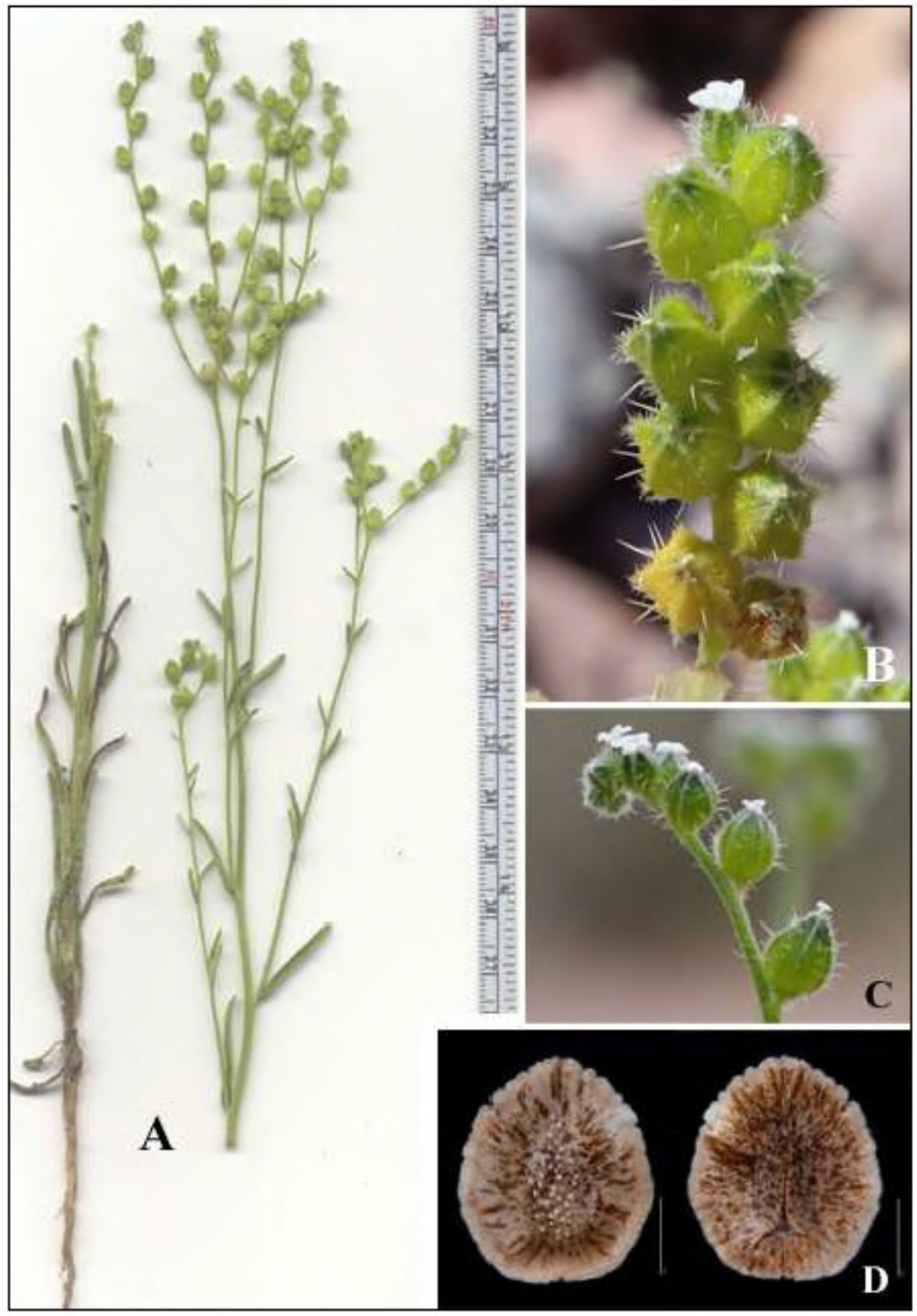

Figure 12. *Cryptantha pterocarya* var. *cycloptera*. Alamo Wash: (A) 5 Mar 2014; (B) 11 Mar 2014. (C) Sierra Los Tanques near Mex Hwy 8, Sonora, 19 Mar 2010. (D) Dorsal and ventral view of nutlet, bar = 1 mm: Hills near Tucson, *Pringle 15 Apr 1884* (SD28896), by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/cryptantha/taxa/C_pterocarya/var_cycloptera/C_pterocarya_v_cycloptera.html

OP: Alamo Canyon, 23 Mar 1941, *McDougall 19*. Victoria Pass, 8 Apr 1941, *McDougall 54*. 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1124*. Twin Peak, 4 Mar 1984, *Van Devender 84-49*. Quitobaquito, 29 Mar 1988, *Felger 88-122*. †Alamo Canyon, nutlets, 8590 & 9570 ybp. †Montezuma's Head: Nutlets, 13,500 ybp; Fruits with calyces and nutlets (nutlets 3, the body 1.6 mm long, gray with tubercles, and very narrow band-like margin, not really winged but the margin is somewhat irregular and not smooth-edged, it appears to be *C. pterocarya* that has not formed a broad wing; the body color and size, shape, and tubercles match in every way except the narrow margin—although the nutlet margins can sometimes be narrow or absent in modern specimens), 20,490 ybp; Fruits with calyces, nutlets 4, nearly all alike, about same size, dull gray with whitish tubercles, and narrow slightly scalloped margins, the wings appear not fully formed, 21,840 ybp. †Puerto Blanco Mts, nutlets, 2340 & 9070 ybp.

CP: Tule Tank, 23 Mar 1935, *Kearney 10893.* Charlie Bell Pass, 3 Apr 1992, *Whipple 3918.* Bassarisc Tank, 26 Feb 1993, *Felger 93-123.* Childs Mt, 2240 ft, 9 Apr 1993, *Felger 93-274* (CAB). Cabeza Prieta Peak, summit, 24 Mar 1995, *Yeatts 3660.1* (CAB).

TA: Tinajas Altas, 1700 to 1900 ft, on cliffs, *Van Devender 10 Mar 1980.* †Butler Mts, nutlets, 10,360 ybp. †Tinajas Altas, nutlets, 11,040 ybp.

††Cryptantha utahensis (A. Gray) Greene

Ephemerals, presently in the Mojave Desert and pinyon-juniper regions of Mohave County, Arizona, above about 950 m, and east-central California to southwestern Utah.

TA: †Tinajas Altas, calyx, nutlets, 11,040 ybp.

Eremocarya

Eremocarya has two species. *Eremocarya lepida* (A. Gray) Greene (*E. micrantha* var. *lepida* (A. Gray) J.F. Macbride) occurs in southwestern California and northwestern Baja California (Simpson et al. 2014).

Eremocarya micrantha (Torrey) Greene

[*Cryptantha micrantha* (Torrey) I.M. Johnston. *Eritrichium micranthum* Torrey]

Dwarf cryptantha. Figures 8E & 13.

Diminutive ephemerals with very slender stems, the roots and stems staining bright red-purple when pressed. This is the smallest cryptantha sensu lato in the region. Plants 3–10 cm tall, branched mostly above, stems very slender, the bark peeling on the lower stems of larger, older plants; hairs small, mostly appressed. Leaves 3–8 mm long, relatively few and scattered, those of the first 1 or 2 nodes opposite and not in a basal rosette. Inflorescence branches not strongly coiled, reaching 5 (15) mm long. Flowers minute, each subtended by a leafy bract; corollas 0.8–1.5 mm wide, white with a yellow center. Nutlets homomorphic or heteromorphic, 4 per fruit, 0.9 mm long, slender, either all smooth or all rough (tuberculate), or with 1 rough and 3 smooth nutlets.

Sandy soils and dunes in the Pinta Sands area of Cabeza Prieta.

Oregon and California to Utah, Baja California, Arizona, and northwestern Sonora, and eastward to western Texas.

CP: Pinacate Lava Fields, 20 Mar 1933, *Shreve 6217.* W side of Pinacate lava, 29 Mar 1985, *McLaughlin 2990.* Pinta Sands, 1 Feb 1992, *Felger 92-17.*

Eucrypta

Delicate plants, aromatic and viscid-glandular. Leaves pinnatifid, opposite below, alternate and reduced above; petiole bases clasping the stem. Flowers axillary or more often on few-flowered slender branches, the pedicels thread-like, elongating in fruit. Calyx divided about ½ to ¾ of the way to the base, the lobes enlarging slightly in fruit. Stamens not protruding from corolla. Style bifid near apex. Seeds several to 16. The plants frequently grow under trees and shrubs and at the base of rocks. This genus includes two species.

1. Leaf lobes shallowly pinnatifid, the tips obtuse-angled rather than rounded; calyx glands not stalked; calyx opening wide (like a dish) at maturity to expose the capsule, the calyx lobes broadly spreading; seeds dimorphic. ..... **Eucrypta chrysanthemifolia**

1. Leaf lobes entire or sometimes few-toothed, the tips rounded; calyx with sessile and usually also stalked glands; calyx lobes erect and enclosing the capsule (only tip of capsule visible); seeds all alike. ..... **Eucrypta micrantha**

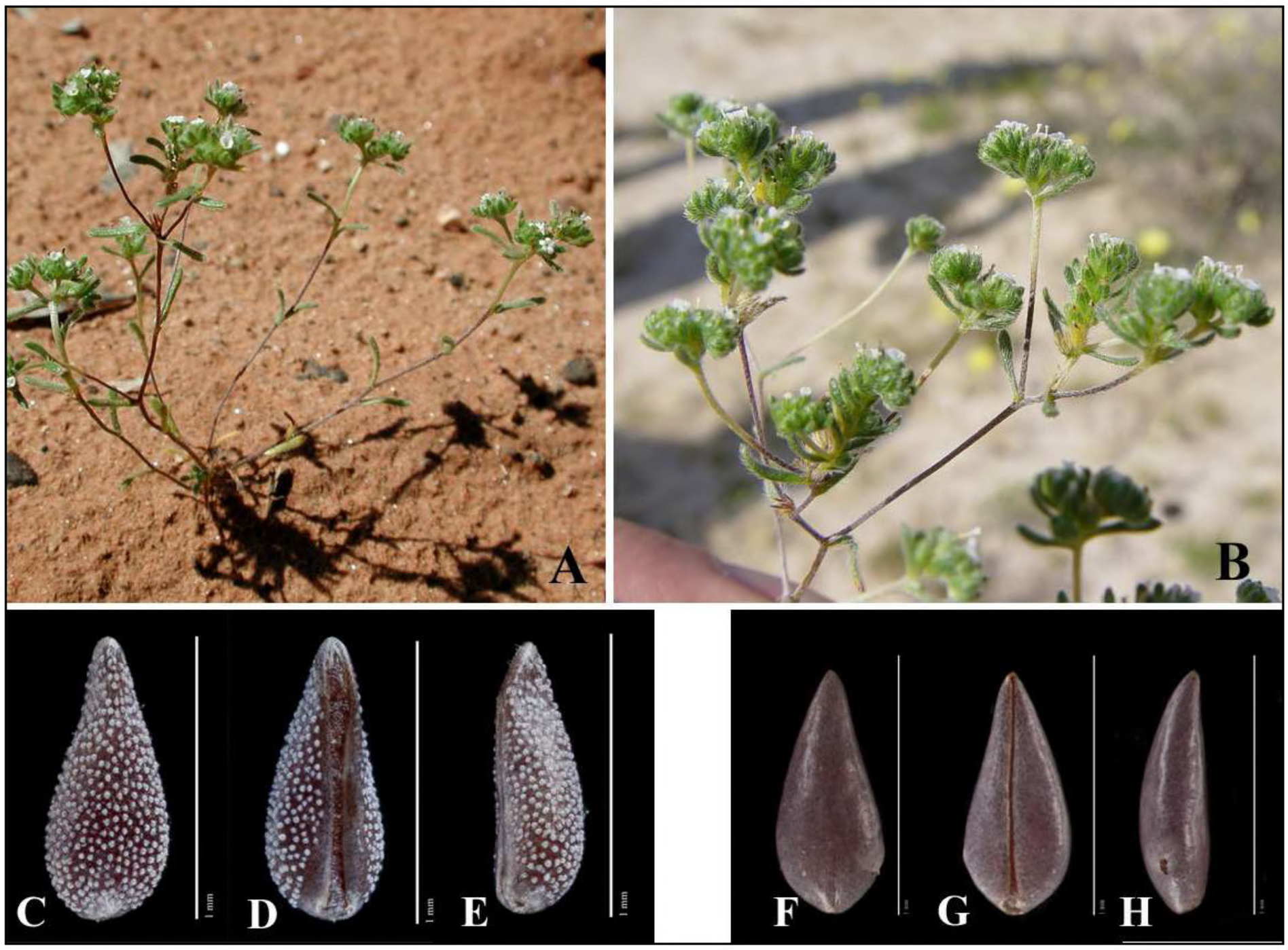

Figure 13. *Eremocarya micrantha*. (A) Red Rock State Park, near Sedona, Yavapai Co., 22 Apr 2001, photo by Max Licher (SEINet). (B) Mohawk Dunes, 3 Mar 2014, photo by Sue Carnahan (SEINet). Nutlets, dorsal, ventral, and lateral views, bar = 1 mm: (C–E) tuberculate (rough) nutlets, Pinyon Wash, Anza-Borrego State Park, San Diego Co., CA, 12 Apr 1963, *Morgan K83* (SDSU 05421); (F–H) smooth nutlets, Borrego Valley, San Diego Co., CA, 25 Mar 1933, *Purer 4943* (SD 39196); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/eremocarya/taxa/E_micrantha/

Eucrypta chrysanthemifolia (Bentham) Greene var. **bipinnatifida** (Torrey) Constance
Spotted hideseed. Figure 14.

Plants highly variable in size depending on soil moisture and shading. Stems 4–15 (25) cm long. Leaves pinnatifid to partially bipinnatifid, mostly 1.5–7 × 0.5–3 (4) cm, "fern-like" or finely dissected. Calyx divided about ⅔ of the way to the base, at maturity (4.5) 5.5–6.5 mm across, rotate, the lobes spreading to reveal the capsule; calyx pubescent but without stalked glandular hairs. Corollas pale lavender. Capsules at maturity separating into 2 conic-hemispherical halves with stout white hairs. Seeds dimorphic within the same capsule: several seeds chunky, blunt-ended, and irregularly lumpy-wrinkled, dark brown with age, 1 mm long, and 2 seeds light brown, 1.2 mm long, flattened and concave on one side, and sharp-edged and strongly convex (almost conic) on the other side, essentially smooth on both sides (the convex side minutely reticulate).

Widespread and often common in canyons and on rocky slopes, especially north-facing, and in washes, and less common on flats and in open areas. High elevations in Ajo Mountains to low elevations across Organ Pipe and much of Cabeza Prieta, especially the eastern two-thirds. *Eucrypta chrysanthemifolia* and *E. micrantha* often grow intermixed; *E. chrysanthemifolia* seems to favor slightly more mesic microhabitats and be the more common of the two at higher elevations.

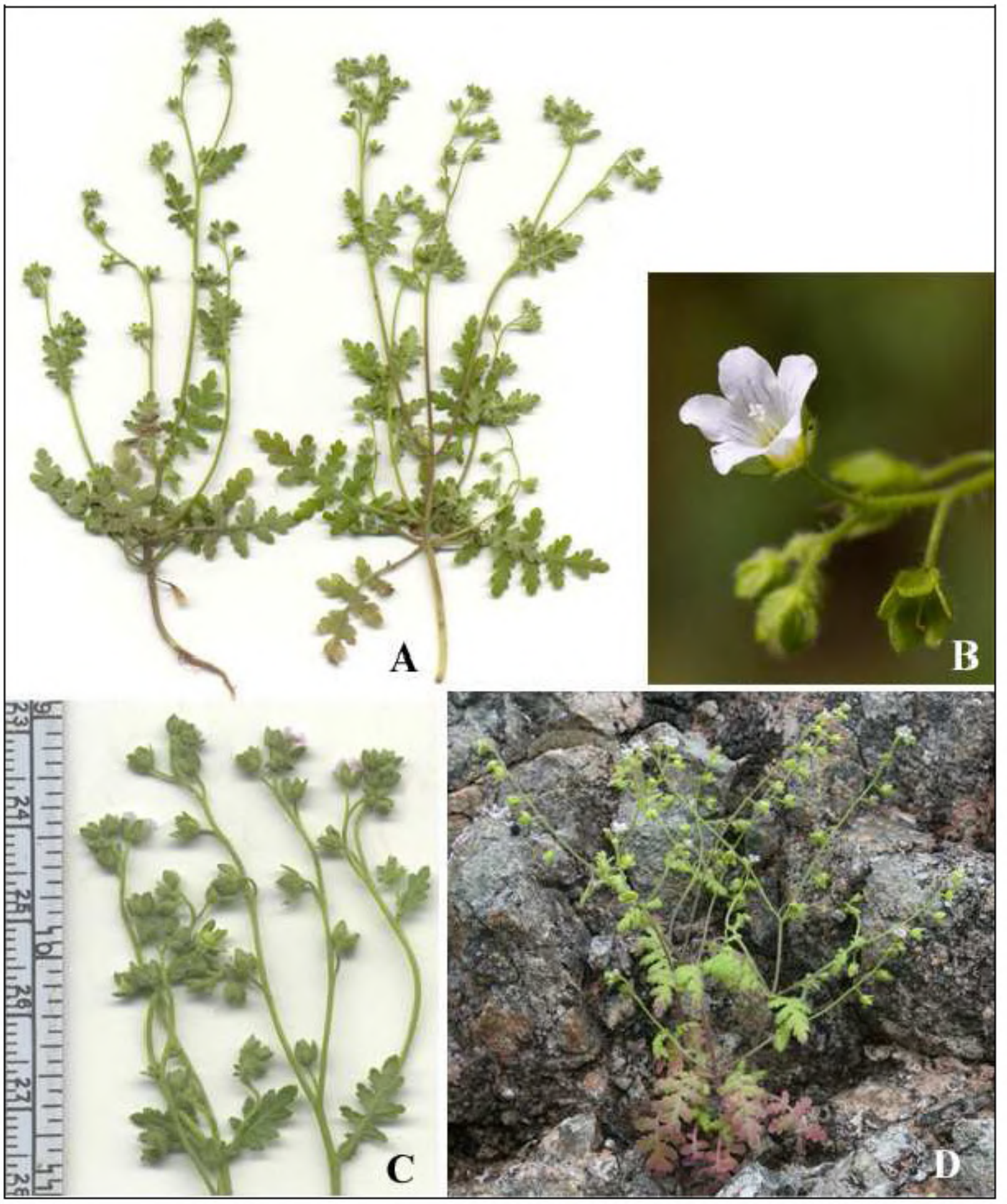

Figure 14. *Eucrypta chrysanthemifolia* var. *bipinnatifida*. (A) Estes Wash, 28 Feb 2009. (B) Jesusita Trail, N of Santa Barbara, Santa Barbara Co., CA, 11 Apr 2009, photo by Patrick Alexander (SEINet). (C) Alamo Canyon near Alamo Well, 11 Mar 2014. (D) Estes Canyon, 5 Mar 2005.

Variety *bipinnatifida* in deserts in Arizona, southern Californica, Nevada, Baja California, and to southern Sonora in thornscrub. Replaced by var. *chrysanthemifolia* on the Pacific coast of California and Baja California.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10827*. Alamo Canyon, 14 Mar 1941, *Benson 10661*. Victoria Pass near Burnham's Mine, 8 Apr 1941, *McDougall 52*. Quitobaquito, 29 Mar 1988, *Felger 88-134*. Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-268*.

CP: Camino del Diablo, 7.6 mi E of Papago Well, 12 Mar 1983, *Daniel 2656* (ASU). Heart Tank, 27 Feb 1993, *Felger 93-158* (CAB).

Eucrypta micrantha (Torrey) A. Heller
Desert hideseed; *peluda*. Figure 15.

Plants with stalked glandular hairs intermixed with non-glandular hairs. Stems often 5–23 (28) cm long, erect to ascending, sometimes spreading on larger plants or when shaded. Leaves pinnatifid, 1.5–5 × 0.5–2.6 cm. Calyx usually divided about halfway or more to the base, beset with stalked glandular hairs as well as non-glandular hairs; fruiting calyx 3–6 mm long, not spreading open at maturity (revealing only the tip of the capsule). Corolla lobes white, pale violet, or lavender, the throat yellow with yellow nectaries and often nectar-filled in the morning. Capsules splitting but the 2 carpels not falling free, the halves obovoid, with obtuse tips. Seeds up to 16 per capsule, all alike, brownish black, 0.8–1 mm long, incurved and cylindrical, with sharply sculptured transverse ridges.

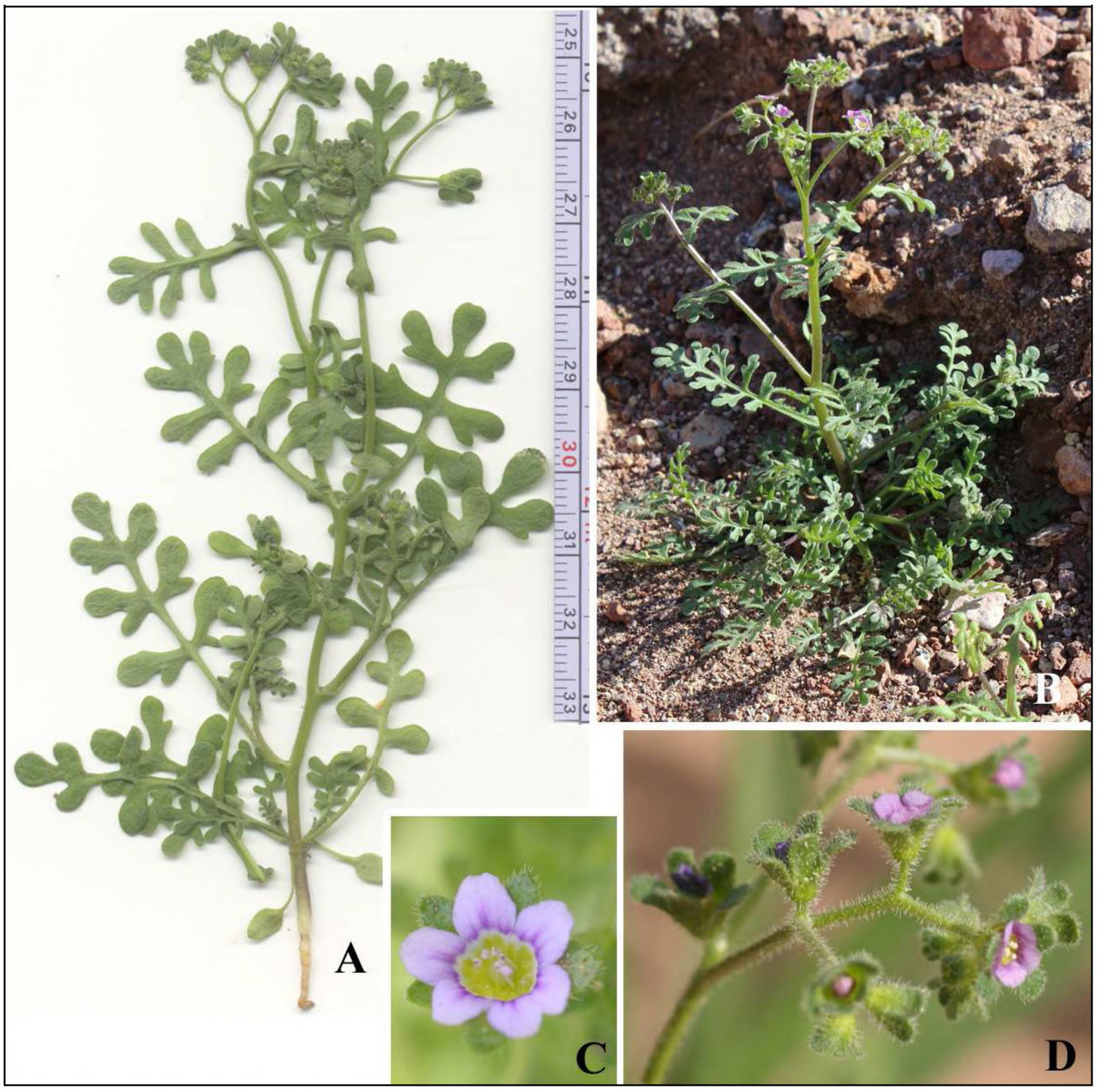

Figure 15. *Eucrypta micrantha*. Kuakatch Wash near Hwy 85: (A) 28 Jan 2013; (C) 13 Mar 2010. (B) Alamo Canyon near the well, 1 Feb 2014. (D) Estes Wash, 21 Mar 2010.

Widespread and common from the Ajo Mountains to low elevations across the flora area.

Southeastern California to Nevada, Utah, and Texas, Baja California, and northern Sonora.

OP: Valley back of Montezuma Head, 28 Mar 1941, *McDougall 43.* Quitobaquito, *Nabhan 18 Feb 1983.* Armenta Road 1.4 mi W of Ariz Hwy 85, 11 Mar 2003, *Felger 03-269.*

CP: Eagle Tank (Simmons 1966). Charlie Bell Pass, 3 Apr 1992, *Whipple 3921.* 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002.* Chico Shuni Well, 2 Feb 2003, *Rutman 2003-40.*

TA: Tinajas Altas, *Van Devender 5 Mar 1983.* Canyon below Raven Butte Tank, 29 Mar 2010, *Felger 10-229.* Coyote Water, 21 Feb 2005, *Felger 05-134.*

Harpagonella

This genus has two taxa.

Harpagonella palmeri (A. Gray) var. **arizonica** I.M. Johnston
Arizona grappling-hook. Figure 16.

Small spring ephemerals resembling a *Pectocarya*. Inflorescences of scorpioid cymes, coiled to one side distally in young plants but appearing racemose in older plants. Flowers small and white. Pedicels ascending, recurved to coiled in fruit. Upper 2 calyx lobes partly fused, the lower 3 calyx lobes smaller and separate from each other. Fruits tightly enclosed in a highly modified and strongly accrescent bur-like calyx becoming indurate with spinescent sepal lobes 3–4.5 mm long with hooked spines and enveloping the nutlets. Nutlets 2, spreading, and heteromorphic, the margins entire.

Common in open, rocky areas in Bull Pasture in the Ajo Mountains and otherwise known in the flora area from the Santa Rosa Mountains.

Variety *arizonica* occurs in southwestern Arizona and northern Sonora, but not in the drier, lower-elevation regions. In a forthcoming publication, Matt Guilliams and Bruce Baldwin treat variety *arizonica* as a distinct species. Variety *palmeri* occurs in southwestern California and Baja California including Isla Guadalupe. The nutlets are similar in both taxa although those of var. *arizonica* are larger and the whole fruit and calyx appendages of var. *arizonica* are larger than those of var. *palmeri.*

OP: Near Diaz Peak, 1070 m, *Dakan 11 Feb 1973* (ORPI). Bull Pasture, 10 Apr 2005, *Felger 05-218.*

Heliotropium

A diverse, worldwide genus of about 250 species.

Heliotropium curassavicum Linnaeus var. **oculatum** (A.A. Heller) I.M. Johnston ex Tidestrom
Alkali heliotrope; *hierba del sapo*; babad 'i:vakĭ, kakaicu 'i:vakĭ. Figure 17.

Perennial herbs often with somewhat thickened rootstocks, and often flowering in the first season; glabrous, semi-succulent to succulent, and bluish glaucous. Above ground parts frost-sensitive. Leaves mostly 2.5–7.5 cm long. Inflorescences terminal, of 2–several spike-like scorpioid cymes, coiled to one side distally. Corollas 4–7 mm wide, white with a yellow center that changes to purple with age. Stigma sessile. Fruits of 4 ovoid nutlets. Growing and flowering with warm to hot weather any time of year.

At various waterholes, occasionally along washes or canyons with temporary water, and moist, alkaline soils at Aguajita, Quitobaquito, and Williams Springs. Mule deer at Dripping Spring in Organ Pipe are known to dig down to eat the roots during the pre-summer dry season.

California east across the Southwest to Texas and northern Mexico; often in alkaline or saline soils. The *Heliotropium curassavicum* complex occurs in warm regions of the Western Hemisphere and is adventive in the Old World.

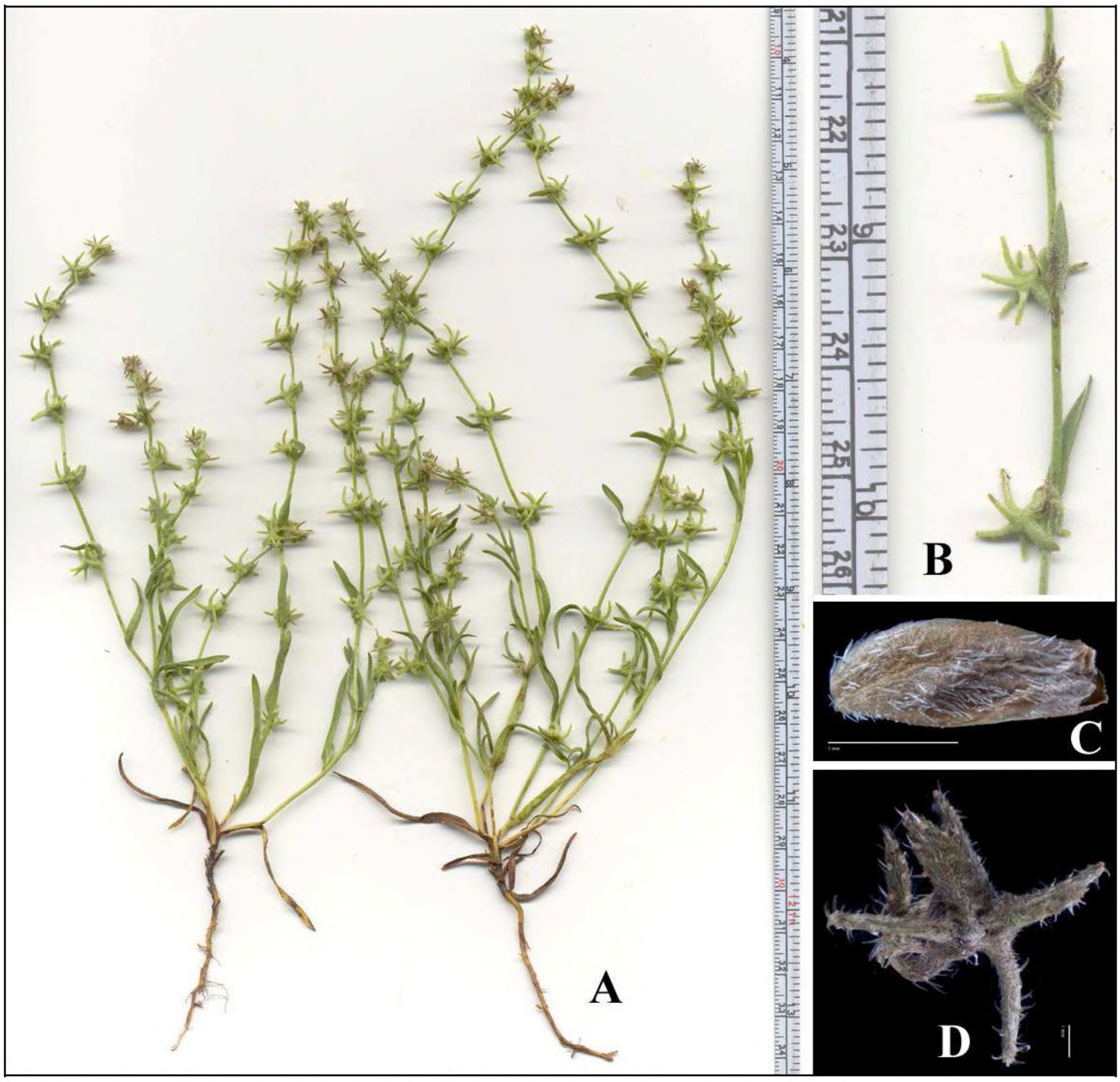

Figure 16. *Harpagonella palmeri*. (A & B) Var. *arizonica*, Bull Pasture, 7 Mar 2014. Nutlet and fruit, bar = 1 mm: (C) var. *palmeri*, nutlet, Monte Vista Ranch S of Ramona, San Diego Co., CA, 18 May 2006, *Rebman 12817* (SD 177861); (D) var. *arizonica*, face view of calyx enclosing the fruit, NE Sierra El Humo, Sonora, 7 May 2005, *Van Devender 2005-842* (ARIZ 377143); by Michael G. Simpson and students, http://www.sci.sdsu.edu/plants/pectocarya/taxa/H_palmeri/

Alkali heliotrope was used by the Hia C-ed O'odham as a remedy for coughs and sore throat (Felger et al. 1992); by the Gila River Pimas to treat sore eyes, sores, and wounds (Russell 1908; Rea 1997); and by Seris to treat colds and stomachaches (Felger & Moser 1985).

OP: Quitobaquito, *Nichol 28 Apr 1939*. Rincon Spring, 13 Apr 1941, *McDougall 90*. William Spring, *Van Devender 30 Aug 1978*. Aguajita Spring, 6 Apr 1988, *Felger 88-276*.

CP: Agua Dulce Spring, 13 Jun 1992, *Felger 92-577*.

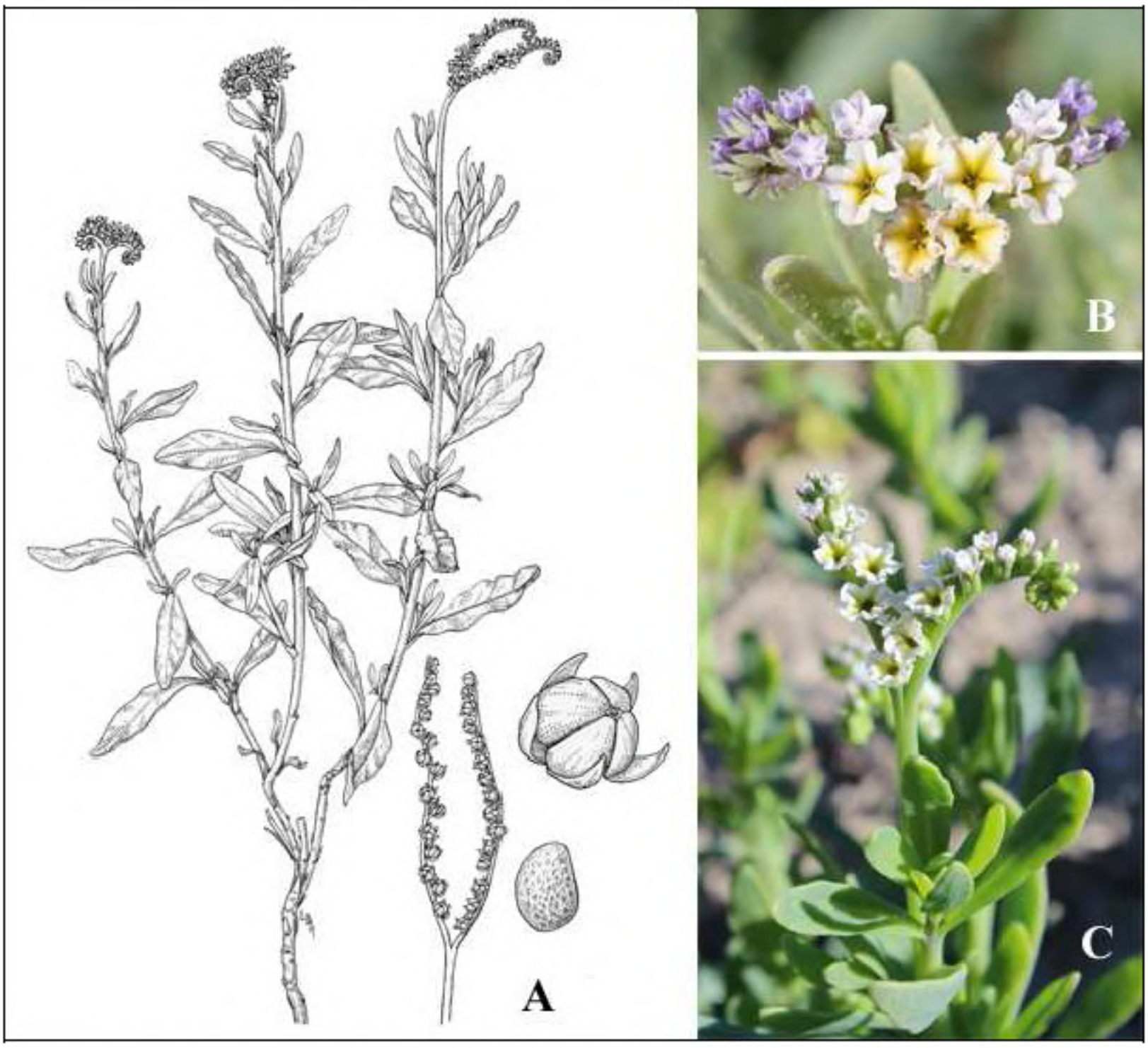

Figure 17. *Heliotropium curassavicum* var. *oculatum*. (A) By Lucretia Breazeale Hamilton. (B) Quitobaquito 15 Feb 2009. (C) Las Conchas, Puerto Peñasco, Sonora, 14 Feb 2014.

Johnstonella

Ephemerals or facultative perennials (two species); germinating, growing, and flowering during cooler seasons. Often with coarse, bulbous-based hairs.

Amphitropical in distribution: southwestern North America (11 species) and southern South America (2 species) (/www.sci.sdsu.edu/plants/johnstonella/taxa.html).

Johnstonella angustifolia (Torrey) Hasenstab & M.G. Simpson
[*Cryptantha angustifolia* (Torrey) Greene]
Narrow-leaf cryptantha, desert cryptantha. Figures 8F & 18.

Plants highly variable in size depending on soil moisture, several to 35 cm tall, the larger plants often globose and bushy. Inflorescences coiled to one side distally. Calyx lobes relatively slender, much longer than nutlets. Corollas often 2–3 mm wide. Nutlets heteromorphic (those in the flora area, or rarely homomorphic, the 4 nutlets of the same size), 4 per fruit, all alike except the nutlet toward the inflorescence axis almost always larger, the 4 nutlets more or less triangular, the

surfaces light brown, tuberculate (evenly dotted with tiny whitish bumps), the margins round-angled (rarely sharp-edged but not prominently knife-edged), the larger nutlet 1–1.4 mm long, the others (0.65) 0.8 (0.9) mm long.

One of the most widespread and abundant winter-spring ephemerals in the region. Many habitats including dunes, washes, creosotebush plains, bajadas, and rocky slopes; often especially large and robust on the Pinta Sands. It has been in the flora area for more than 13,500 years.

Dry regions of southwestern United States and Mexico in Baja California and Sonora south to the vicinity of Guaymas. This is one of those itchy plants that get in your socks and sleeping bag.

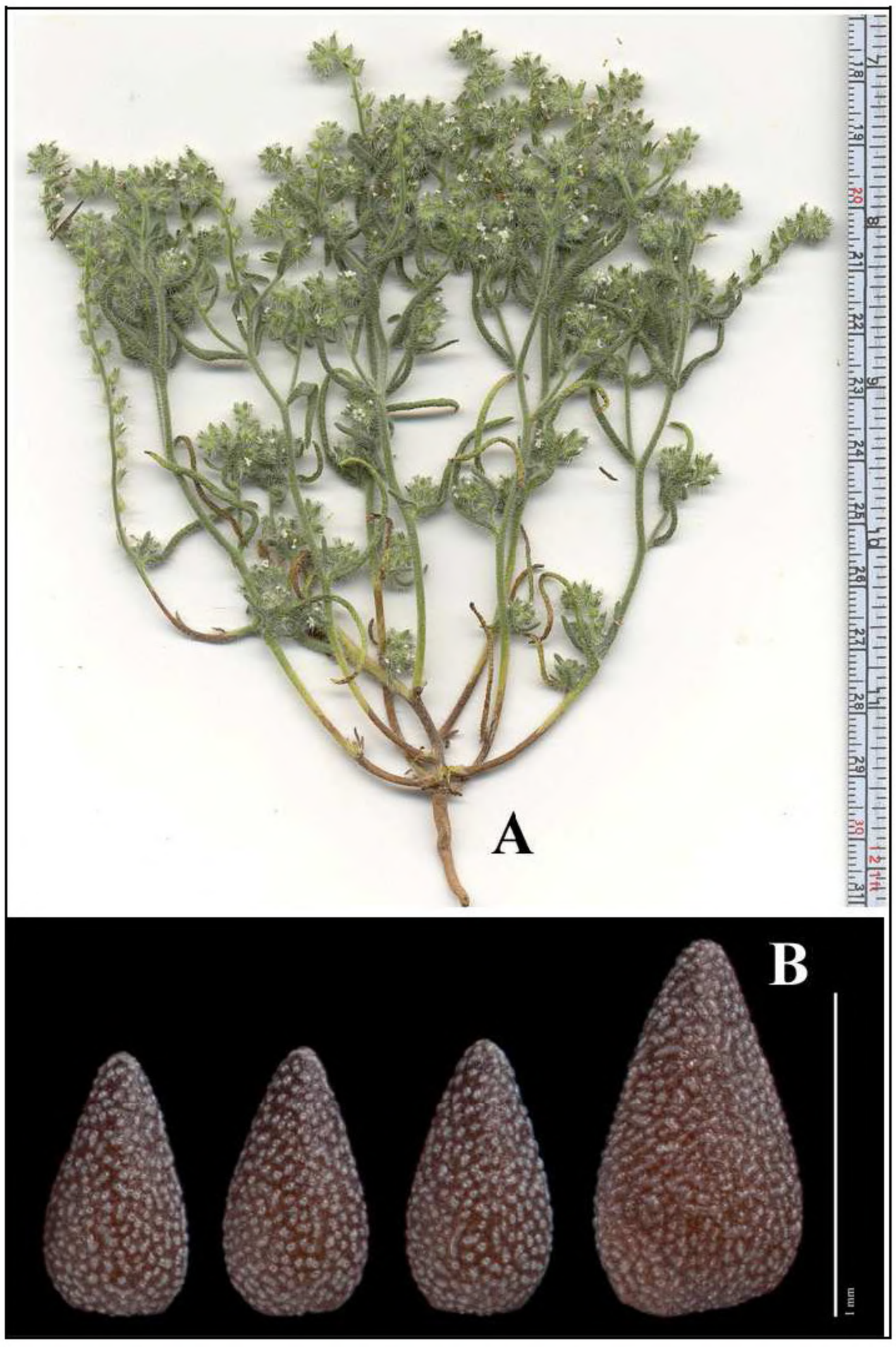

Figure 18. *Johnstonella angustifolia*. (A) Alamo Wash, 24 Mar 2008. (B) Dorsal view of heteromorphic nutlets, bar = 1 mm; near Cottonwood Springs Campground, Joshua Tree National Park, Riverside Co., CA, 1 Apr 2008, *Hasenstab 52* (SDSU 18687); by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/johnstonella/taxa/J_angustifolia/>

OP: 1 mi N of Sonoyta, 22 Mar 1941, *McDougall 17.* Quitobaquito, 14 Apr 1963, *Felger 7671.* Senita Basin, 26 Feb 1978, *Bowers 1093.* 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1593.*

CP: Sandy soil, Pinacate Lava Fields, 20 Mar 1933, *Shreve 6219.* N of Las Playas, in malpais desert, *Darrow 15 Apr 1941.* Pinta Sands, 13 Mar 1983, *Eiber 39a.*

TA: Tinajas Altas, *Van Devender 5 Mar 1983.*

Johnstonella costata (Brandegee) Hasenstab & M.G. Simpson
[*Cryptantha costata* Brandegee]
Ribbed cryptantha

Stems erect, the branches somewhat stiff and straight (not as open and loose as in *Cryptantha barbigera* or *J. angustifolia*). Corollas 1–2 mm wide. Nutlets 4, homomorphic (or 1 sometimes larger), the margins knife-edged but not winged; inner face of nutlet flat; back of nutlet smooth and notably convex.

Not known from the flora area but should be sought on dunes and sand soils in the southwestern part of Cabeza Prieta and in the Tinajas Altas Region in the Lechuguilla Valley and west of the Tinajas Altas Mountains. The nearest known records are from the Yuma dunes near the southwest margin of the Tinajas Altas Region, the Mohawk Dunes, and the Gran Desierto dunes and sand soils in adjacent Sonora just south of Arizona (e.g., Felger 2000).

Dunes and sand soils in the Mojave and Sonoran Deserts: southwestern Arizona, Baja California, California, and Nevada.

Yuma Co.: Mohawk Dunes, *Darrow 23 Apr 1938.* Goldwater Range, SE corner of Yuma Dunes, 0.4 km N of Mexico border, 0.4 km NE of USMEX Hill, UTM 12 342400, 3585400, 121 m, rolling dunes, 13 Apr 1993, *Walter 67* (ASU).

Sonora: 20 mi (Mex 2) E of San Luis [Río Colorado], 9 Apr 1966, *Bezy 458.*

Johnstonella holoptera (A. Gray) Hasenstab & M.G. Simpson
[*Cryptantha holoptera* (A. Gray) J.F. Macbride]
Winged cryptantha. Figures 8G & 19.

Plants extremely variable in size; facultative ephemerals to perennials (probably short-lived) becoming woody at the base, the perennials most frequent at higher elevations. Herbage with conspicuously coarse hairs, the leaves gray-green. Inflorescences coiled to one side distally. Flowers often very fragrant, the corollas 3–4 mm wide. Nutlets 4, homomorphic, 1.2–2 mm long, light brown with a sharp-edged ribbon-like wing, 4 per fruit.

Granitic and basalt hills and mountains and sometimes along adjacent washes in the south-central and southwest parts of Cabeza Prieta, especially on north-facing slopes, canyons, and arroyos.

Southeastern California, western Arizona, northeastern Baja California, and northwestern Sonora.

Johnstonella holoptera is typically described as only possessing homomorphic nutlets. However, *J. inaequata* (I.M. Johnston) Brand, with heteromorphic nutlets, has been incorrectly synonymized with *J. holoptera* by various authors, most recently by Kelley and Wilkin (1993; Ronald B. Kelley, pers. comm. to R. Felger, 2014). *J. inaequata* occurs in southern California and southern Nevada to northwestern Arizona and southwestern Utah.

CP: 26 mi W of Papago Well, Tule Mts, 15 Apr 1941, *Benson 10791.* Tule Tank, 14 Apr 1992, *Harlan 291* (CAB). Cabeza Prieta Peak, S-facing side of summit, *Yeatts 24 Mar 1995* (CAB).

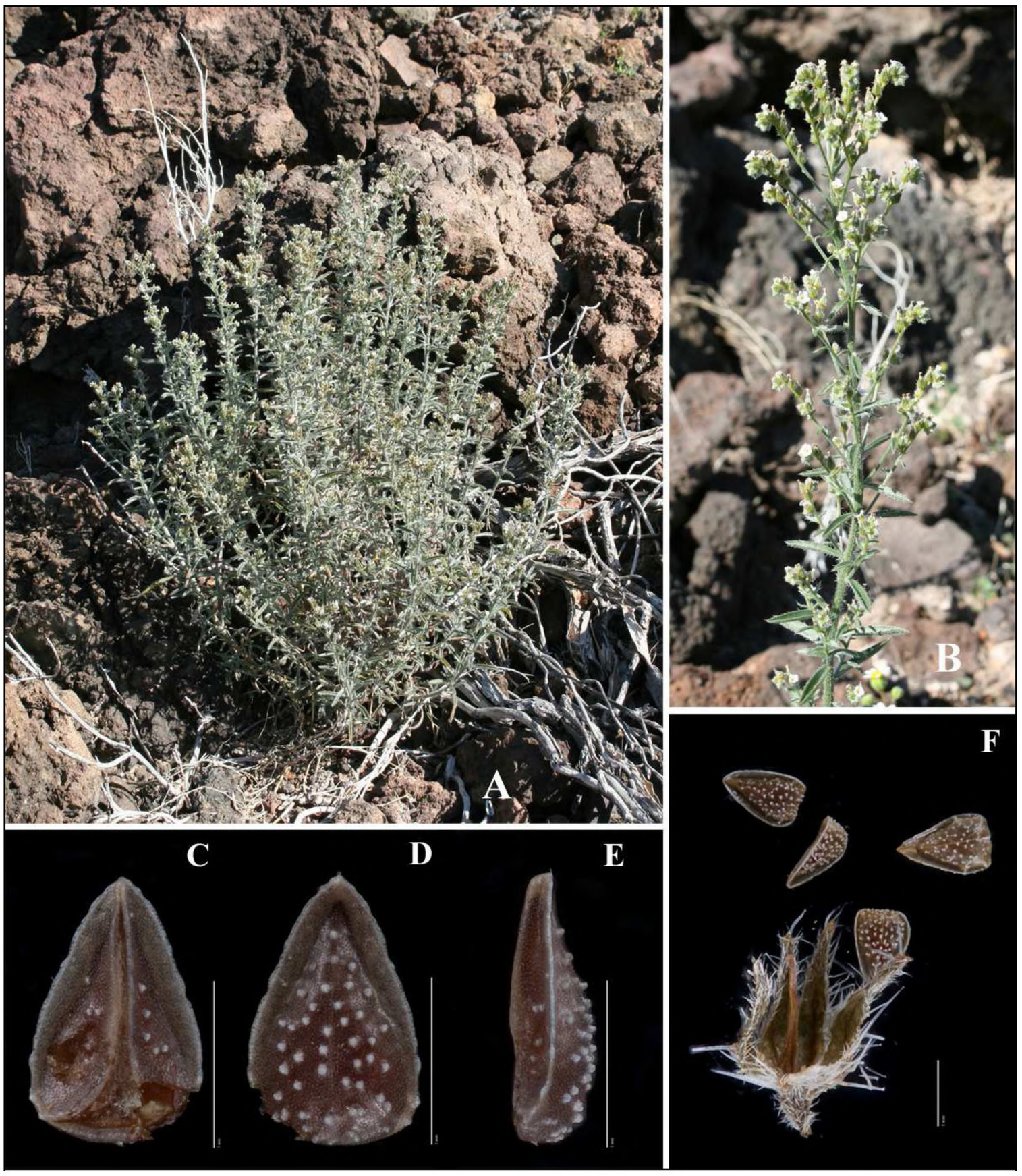

Figure 19. *Johnstonella holoptera*. (A & B) Near Red Cone campground, Pinacate Biosphere Reserve, Sonora, 3 Mar 2009. Calyx and nutlets, bar = 1 mm, Agua Chale, Baja California, 21 Apr 1960, *Moran 8212* (SD 54473): (C–E) ventral, dorsal, and lateral views; (F) calyx and nutlets; by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/johnstonella/taxa/J_holoptera/>

Johnstonella racemosa (S. Watson ex A. Gray) Brand
[*Cryptantha racemosa* (S. Watson ex A. Gray) Greene. *Eritrichium racemosum* S. Watson ex A. Gray]
Bushy cryptantha. Figures 8H & 20.

Ephemerals to perennial herbs or subshrubs (probably short-lived) to 0.5+ m tall, often woody at the base with several upright main axes, shredding bark, and short branches above; also flowering in the first season but these mostly do not survive the summer drought. Inflorescence branches not strongly coiled distally. Corollas 3–3.5 mm wide. Nutlets heteromorphic, 4 per fruit, light brown with narrow, cord-like margins, of similar shape and ornamentation but the larger nutlet 2 mm long, the others 1.1–1.4 mm long.

Granitic slopes of the Tinajas Altas Mountains, one record in Cabeza Prieta, and in adjacent areas in Sonora. It has been in the flora area for more than 11,000 years.

This desert species occurs in the Mojave Desert in California and Nevada, and southward in the Sonoran Desert to northern Baja California and northwestern Sonora. It is distinguished from the related *C. holoptera* by having non-coiled inflorescence branches and markedly heteromorphic nutlets with narrow, cord-like margins.

CP: Buckhorn Tank, ca. 35 mi S of Mohawk, 14 Jul 1955, *Ahles 9089* (ASC).
TA: Vicinity of Tinajas Altas, 1700 to 1900 ft, on cliffs, *Van Devender 5 Mar 1983.* †Butler Mts, calyx, nutlets, 10,360 ybp. †Tinajas Altas, calyces, nutlets, 8970 to 11,040 ybp (5 samples).

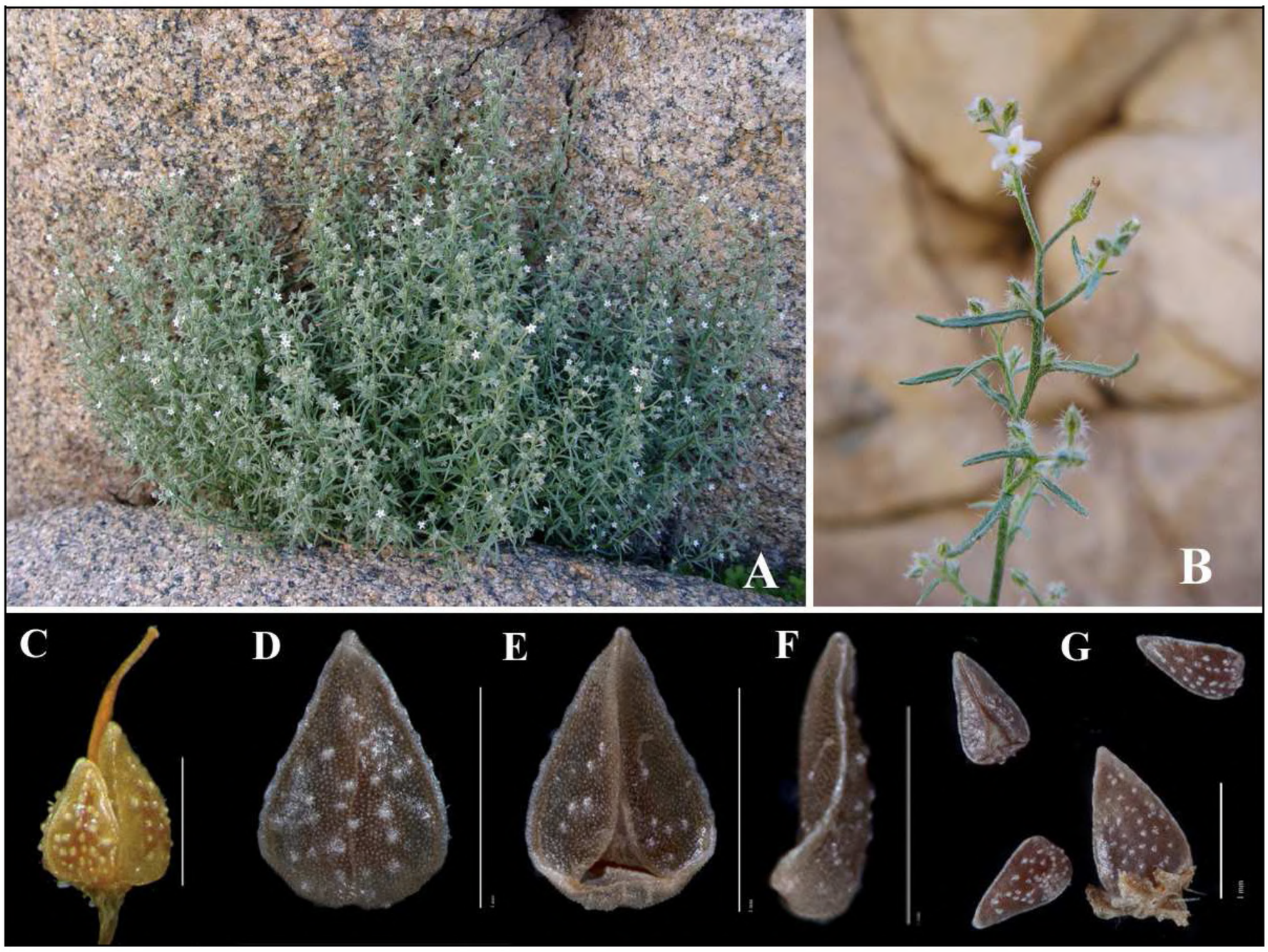

Figure 20. *Johnstonella racemosa.* (A & B) S of Cottonwood Springs, Joshua Tree National Park, Riverside Co., CA, *Hasenstab 68* (SDSU 18710). Fruit, calyx, and nutlets, bar = 1 mm: (C) fruit with heteromorphic nutlets, *Hasenstab 68*; (D–F) nutlet, left to right, dorsal, ventral, and lateral views, W slope of Providence Mts, San Bernardino Co., CA, 28 May 1941, *Wolf 10837* (SD 42216); (G) calyx and nutlets, Darwin Falls, Inyo Co., CA, 15 May 1931, *Hoffman 315* (SD 107309); by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/johnstonella/taxa/J_racemosa/>

Lappula

This genus includes more than 60 species in Eurasia and Susan Rolfsmeier's (2013) dissertation establishes 12 native and various non-native taxa in North America. North American taxa include two varieties of *L. occidentalis*: var. *occidentalis* with homomorphic nutlets and var. *stricta* with heteromorphic nutlets. The regional synonymized representative of var. *stricta* is the Rydberg species *L. leucotricha* (type from Pima County), which Ronald B. Kelley (pers. comm. to R. Felger, 2014) found in numerous locations collecting in southern Arizona in spring 2013, usually in wash habitats. He also collected the Tucson regional volcanic endemic *L. coronata* Greene, which is morphologically quite distinctive from var. *stricta* and recognized by Rolfsmeier (2013) as a distinct species. Rolfsmeier also shows that *L. redowskii* (Hornemann) Greene is restricted to Eurasia.

Lappula occidentalis (S. Watson) Greene var. **stricta** (S. Watson) S.J. Rolfsmeier
[*L. leucotricha* Rydberg]
Flat-spine stickseed. Figure 21.

Spring ephemerals with coarse hairs; taprooted; 1 to several or more erect, slender, major stems, branching mostly above the middle. Flowering branches raceme-like at maturity. Flowers small, pale blue or white. Fruits bur-like; nutlets 4 per fruit, heteromorphic, the body 2–2.3 mm long, ovate-triangular, the odd nutlet with barb-tipped spines separated at base, the other three nutlets with winged margins formed of stout, barb-tipped spines fused at base.

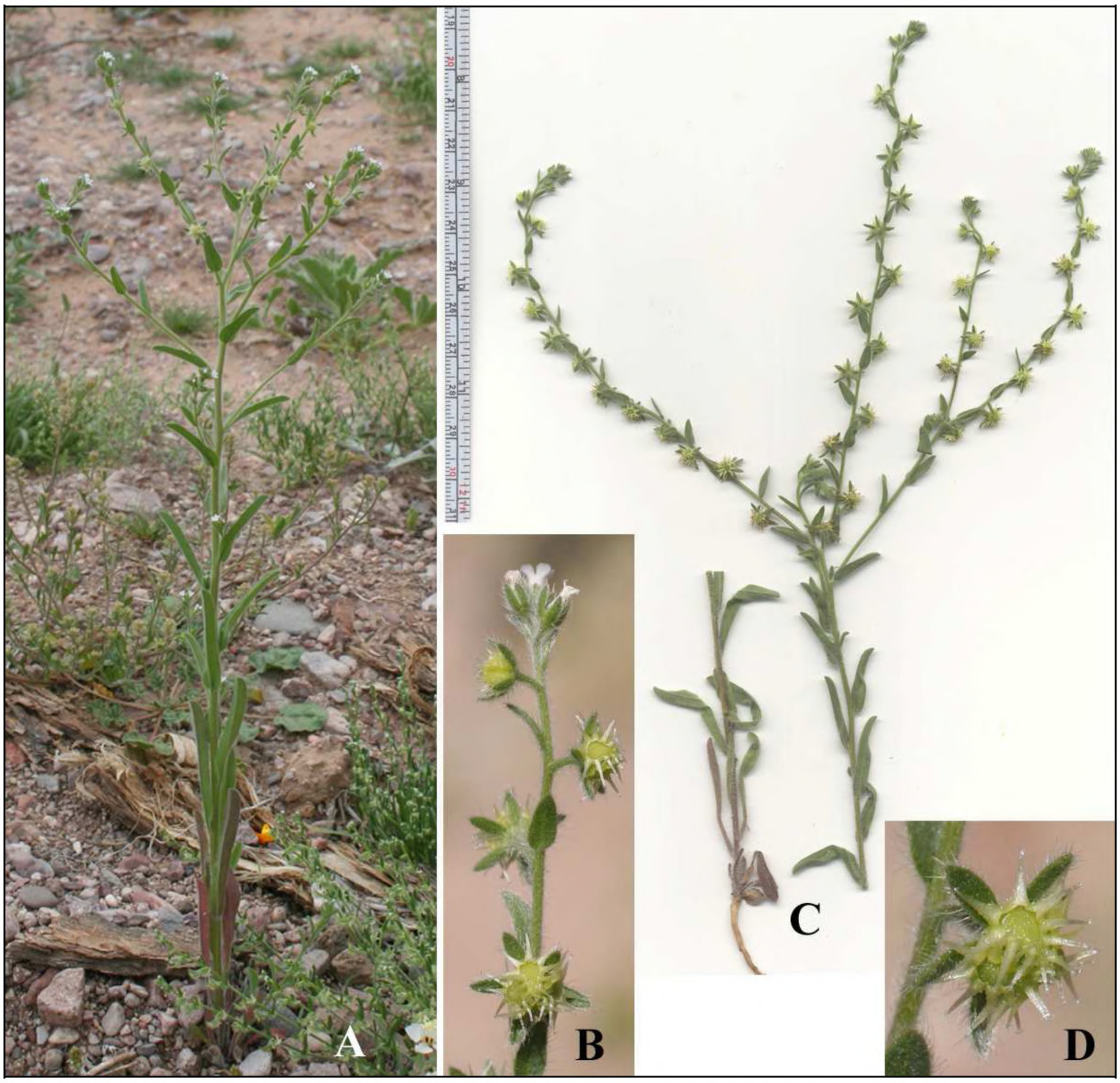

Figure 21. *Lappula occidentalis* var. *stricta*. (A) Alamo Well, 11 Mar 2014. (B & D) Victoria Mine, 1 Apr 2010. (C) Alamo Canyon, 11 Mar 2014.

Locally in sandy-gravelly and silty soils of washes and bajada plains, often beneath mesquites and in disturbed habitats. This or a similar *Lappula* has been in the Ajo Mountains for 22,000 years.

This species occurs from Sonora and Arizona eastward to Oklahoma and north to Montana, North Dakota, and British Columbia, although Rolfsmeier (2013: 151) states that, "*L. occidentalis*

was . . . problematic to circumscribe." Variety *stricta* occurs in Arizona, Idaho, Nevada, Oregon, Utah, and the Sonoran Desert in Mexico. As a genus in this floristic area, *Lappula* most likely represents a Pleistocene relict. *Lappula occidentalis* var. *stricta* tends to exist in ephemerally moist habitats such as shaded washes, riparian zones, roadsides, and ruderal areas, but it appears to be a native element of the flora (Ronald B. Kelley, pers. comm. to R. Felger, 2014).

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939* (ORPI). Quitobaquito, 17 Apr 1952, *Parker 7990.* Growler Wash at Bates Well Road, 30 Mar 1978, *Bowers 1152* (ORPI). 0.6 mi E of Lukeville, broad sandy wash, 20 Feb 1988, *Felger 88-06.* †Montezuma's Head, nutlets, 13,500 to 21,840 ybp (4 samples).

CP: Near Sheep Tanks, 28 Mar 1935, *Kearney 11029.* Cameron Wash, *Johnson 26 Mar 1960.* San Cristobal Wash, road from Bates Well to Papago Well, 31 Jan 1992, *Felger 92-5.* Charlie Bell Road near east Refuge boundary, 25 Feb 1993, *Felger 93-57.*

Nama – Purple mat

Cool-season ephemerals, first flowering as rosette plants, with slender stems. Leaves alternate and entire (those in the flora areas). Flowers solitary or in short cymose clusters. Calyx divided nearly or entirely to the base. Corollas readily deciduous, the lobes rounded and usually spreading. Stamens not exserted. Capsules many seeded.

Southwestern United States to tropical America and Hawaii; 55 species.

1. Plants semi-prostrate, matted; longer stem hairs 0.4 mm long; corollas bright lavender-pink; seeds dark brown, about as wide as long. ..... **Nama demissum**
1. Plants erect with ascending branches, with age sometimes spreading-prostrate but not matted; longer stem hairs 0.8–1.2 mm long; corollas pale lavender to purple; seeds yellowish, about twice as long as wide..... **Nama hispidum**

Nama demissum A. Gray var. **demissum**

Purple mat. Figure 22.

First flowering as rosette plants, often developing slender stems 2–10 cm long, prostrate to prostrate-ascending at tips. Stem hairs (0.3) 0.4 (0.5) mm long, often not straight, and relatively soft. Leaves 1.5–4 cm long, narrowly spatulate, gradually narrowed to a winged petiole, the upper leaves smaller, sessile, and mostly in compact terminal clusters. Corollas bright lavender-pink (rarely white), 10–12 mm long. Basal portion of filaments (the part fused to corolla tube) narrowly winged. Styles 2, distinct to the base. Seeds chunky and ovoid, dark brown at maturity, 0.55–0.6 × 0.5 mm, the surface lumpy with transverse grooves or pits.

Mostly along washes and gravelly soils of bajadas and plains, often in open, otherwise barren areas such as desert pavement. Localized in portions of the western part of Cabeza Prieta and the Tinajas Altas Range.

California to Baja California Sur, Utah, Arizona, and northwestern Sonora. The plants are more compact, closer to the ground, generally smaller and with brighter and darker-colored flowers than the more common *N. hispidum*. Two other varieties of *N. demissum* occur in the Baja California Peninsula and California.

CP: E side of Tule Mts, 22 Mar 1992, *Harlan 112* (CAB). 1 km N of Tule Well, 11 Apr 1993, *Felger 93-442.*

TA: 1 km SE of mouth of Borrego Canyon, 18 Mar 1998, *Felger 98-112.*

Figure 22. *Nama demissum* var. *demissum*. Cinder flats ENE of Red Cone campground, Pinacate Biosphere Reserve, Sonora, 7 Mar 2009.

Nama hispidum A. Gray
[*N. hispidum* var. *spathulatum* (Torrey) C.L. Hitchcock. *N. coulteri* A. Gray. *N. hispidum* var. *coulteri* (A. Gray) Brand]
Morada; bristly nama. Figure 23.

First flowering as rosette plants, often developing stems 5–30 cm long, erect to ascending or spreading with age. Larger stem hairs (0.8) 1–1.2 mm long, bristly, and straight. Leaves 1.5–4.5 cm long, narrowly spatulate, gradually narrowed to a winged petiole, the upper leaves smaller and sessile. Corollas lavender, (10) 13–15 mm long. Styles 2, distinct to the base. Seeds 0.5–0.6 mm long, ellipsoid-ovoid, about twice as long as wide, yellowish, the surface minutely reticulate.

Widespread and common across the flora area, especially washes, sandy flats, and bajadas.

Southeastern California to Baja California Sur, western Texas, Nevada, Utah, and Arizona to northern mainland Mexico from Sonora and Sinaloa to Coahuila and Nuevo León. The varieties do not seem to be well marked, although if recognized, those in southern Arizona are var. *spathulatum* (Torrey) C.L. Hitchcock.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. Quitobaquito, 18 Feb 1978, *Fay 744*. Puerto Blanco Drive (two-way section) 5.3 mi W of Hwy 85, 26 Feb 1978, *Bowers 1073*.
CP: 1 mi N of Cabeza Prieta Tanks (Simmons 1966). San Cristobal Wash, 20 Mar 1992, *Harlan 7* (CAB). Pinta Sands, 11 Apr 1993, *Felger 93-431*. 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002*.
TA: Coyote Water, 25 Oct 2004, *Felger 04-52*. Surveyors Canyon, 29 Mar 2010, *Felger 10-214*. Frontera Canyon, 18 Mar 1998, *Felger* (observation).

Pectocarya – Comb-bur

Small, cool-season ephemerals. Leaves linear to narrowly oblanceolate or narrowly elliptical, often small, cotyledons and first pair opposite, appearing as a basal rosette, the others alternate Inflorescences of scorpioid cymes, not tightly coiled distally or only moderately so (those in the flora

area), potentially appearing racemose in age. Flowers minute, opening at maturity (chasmogamous) or sometimes not opening (cleistogamous); corollas white, sometimes with a yellow throat. Fruits monomorphic or dimorphic (basal and cauline fruits dissimilar). Nutlets homomorphic or heteromorphic (nutlets within a fruit dissimilar), usually 4, in 2 pairs spreading apart like miniature gaping jaws, the margins with bristles and/or teeth. (Key and descriptions based in part on Guilliams et al. 2013).

Western North America from southwestern Canada (British Columbia) to northwestern Mexico (Baja California Sur and Sonora), and South America in Bolivia, Peru, Chile, and Argentina; 13 species, 14 taxa.

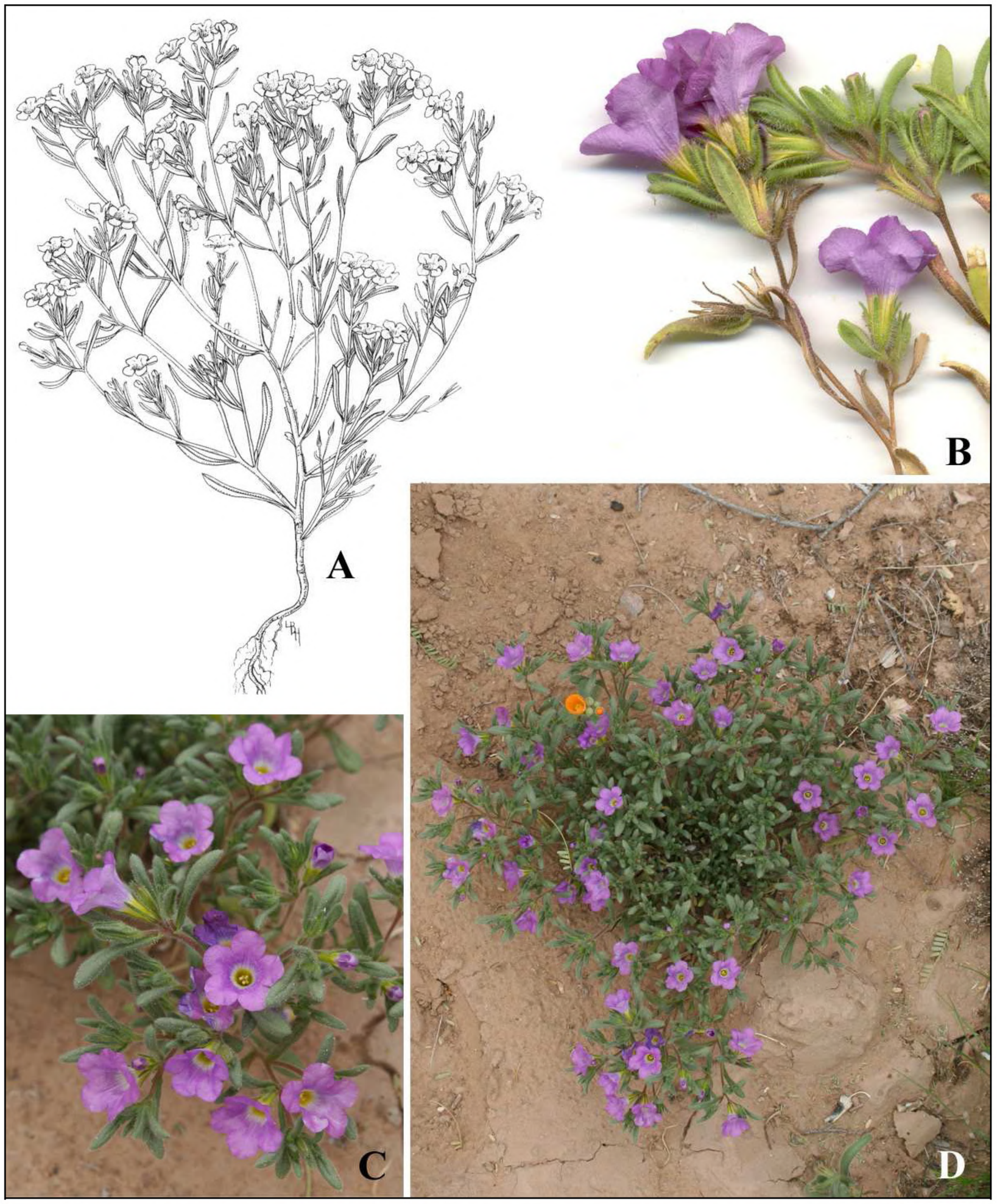

Figure 23. *Nama hispidum.* (A) By Lucretia Breazeale Hamilton. (B) Ajo, Pima Co., 17 Mar 2003. (C & D) Hwy 85, 25 mi N of Ajo, 8 Mar 2008.

1. Cauline fruits with nutlets not all alike (nutlets heteromorphic)—the pairs dissimilar in size and the margins also dissimilar, and each nutlet within a pair slightly different.

2. Pedicel of cauline fruits not fused to lower, inner nutlet; nutlets of basal fruits and cauline fruits similar (fruits monomorphic), the nutlets of cauline fruits all in one plane ..... **Pectocarya anisocarpa**

2. Pedicel of cauline fruits fused to lower, inner nutlet; the nutlets of basal fruits and cauline fruits dissimilar (fruits dimorphic), the nutlets of cauline fruits in two planes ..... **Pectocarya heterocarpa**

1. Cauline fruits with nutlets all alike (or essentially so, nutlets homomorphic).

3. Nutlets straight or only slightly recurved, the nutlet margin with a conspicuous wing of tissue, the wing toothed, wing and teeth lighter colored (often yellowish) than body of nutlets ..... **Pectocarya platycarpa**

3. Nutlets conspicuously recurved, the nutlet margin without wing of tissue or wing very narrow and about the same color as the body ..... **Pectocarya recurvata**

Pectocarya anisocarpa Veno
Unequal comb-bur

Plants prostrate to decumbent, branched from base. Flowers opening at maturity (chasmogamous); corollas (limb width) 0.5–1 (1.5) mm wide and 0.5–2.3 mm long. Fruits within a plant similar (monomorphic). Nutlets within a fruit dissimilar (heteromorphic). Nutlets away from inflorescence axis winged, wing undulate to widely-toothed, with uncinate bristles. Nutlets toward the inflorescence axis smaller and with wing reduced or absent. All nutlets with a pectinate fringe of uncinate bristles distally.

This species, described in Guilliams et al. (2013), is likely to be in the northern part of the flora area. It occurs along the I-8 highway west of Gila Bend.

Central California to southwestern Utah, southward through central and southern Arizona, and rare in Baja California.

Pectocarya heterocarpa (I.M. Johnston) I.M. Johnston
Mixed-nut comb-bur. Figure 24.

Plants prostrate to ascending, branched from base. Cauline and basal flowers dissimilar. Cauline flowers open at maturity (chasmogamous) and fragrant. Corollas white with a yellow throat, 1.5–2 mm wide, the stigma green. Fruits within a plant dissimilar (dimorphic). Nutlets within cauline fruits dissimilar (heteromorphic), often moderately curved or slightly curled inward (not outward), one pair larger, winged and with marginal teeth, the other pair not winged and lacking marginal teeth, each nutlet within a pair slightly different. Lowermost flowers often cleistogamous.

Widespread on sandy soils, especially low, stabilized dunes and sand flats, washes and their floodplains, bajadas, and sometimes hills and mountains. Its history in the flora area extends to 10,400 years.

Southern California to western Texas and Utah, and southward to Baja California and northern Sonora.

OP: Road to Walls Well, 26 Mar 1941, *McDougall 40*. Near Dripping Springs, 16 Apr 1952, *Parker 7936*. Quitobaquito, 6 Apr 1988, *Felger 88-270*. †Puerto Blanco Mts, nutlets, 990 ybp.

Figure 24. *Pectocarya heterocarpa*. CD Trail near Engineer Canyon, Burro Mts, Grant Co., NM, 20 Apr 2010: (A) mature plant; (B) nutlets, note two are broadly winged and two are wingless; (C) flower. Photos by Russell Kleinman (gilaflora.com).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3953*. Pinacate Lava Flow, sand hill, 1 Feb 1992, *Felger 92-18*. Camino del Diablo at San Cristobal Wash, 26 Feb 1993, *Felger 93-109*

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-137*. †Butler Mts, nutlets, 10,360 ybp.

Pectocarya platycarpa (Munz & I.M. Johnston) Munz & I.M. Johnston
Broad-winged comb-bur. Figure 25.

Plants erect to widely ascending, and branched from base. Flowers open at maturity (chasmogamous); corollas 1.25–2 mm wide. Fruits within a plant similar (monomorphic). Nutlets homomorphic or heteromorphic, straight or slightly recurved, the margins yellow and winged, the wing wide with conspicuous teeth. When heteromorphic, those nutlets toward the inflorescence axis smaller and with reduced ornamentation. Distinguished from other regional comb-burs by the generally larger-sized plants, larger and wider nutlets, and fewer and larger teeth on the nutlet wing.

Widespread including washes, desert flats, bajadas, and rocky slopes. It was at Tinajas Altas 10,600 years ago.

Northern Sonora, Baja California, Arizona, southeastern California, southern Nevada, and southwestern Utah.

OP: Puerto Blanco Mts, *Nichol 25 Feb 1939*. Alamo Canyon, 14 Mar 1941, *Benson 10664*. Near Dripping Springs, 16 Apr 1952, *Parker 7935*. Quitobaquito, 29 Mar 1988, *Felger 88-127*. Aguajita Wash, *Beale 8 Apr 1988* (ORPI).

CP: Growler Mts above Charlie Bell Wash, 1700 ft, 3 Apr 1992, *Whipple 3949*. Cristobal Wash, 11 Apr 1992, *Harlan 149* (CAB). Wash below Heart Tank, 27 Feb 1993, *Felger 93-167* (CAB).

Figure 25. *Pectocarya platycarpa*. (A) Kuakatch Wash near Hwy 85, 13 Feb 2005. Nutlets, bar = 1 mm: (B) dorsal and (C) ventral view, 3 mi S of Ajo on Hwy 85, 31 Mar 1962, *Howe 3182* (SDSU 04020); by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/pectocarya/taxa/P_platycarpa/>

TA: Tinajas Altas, *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-137A*. †Tinajas Altas, nutlets, 10,600 ybp.

Pectocarya recurvata I.M. Johnston
Arched comb-bur. Figure 26.

Plants erect to ascending, branched from base. Flowers open at maturity (chasmogamous); corollas 0.75–2 mm wide. Fruits within a plant similar (monomorphic). Nutlets within a fruit similar (homomorphic), relatively small, narrow, conspicuously recurved (arched or curled back), the margins not winged or with a very narrow wing about the same color as the nutlet body, the teeth distinct.

Widespread in Organ Pipe and the east side of Cabeza Prieta; washes, desert flats, bajadas, and rocky slopes.

Northern Sonora, Baja California, southeastern California, Arizona, southern Nevada, New Mexico, and southern Utah.

OP: Near Dripping Springs, 16 Apr 1952, *Parker 7936A*. Canyon Diablo, 13 Feb 1978, *Bowers 1060*. Quitobaquito, 29 Mar 1988, *Felger 88-126*.

CP: S of Camino del Diablo on road to Agua Dulce Pass, 19 Mar 1987, *Elias 10198*. Charlie Bell Road at Daniels Arroyo, 10 Apr 1993, *Felger 93-362*. Childs Mt, 2240 ft, 25 Feb 1993, *Felger 93-32A*.

Figure 26. *Pectocarya recurvata*. (A) Alamo Wash, 5 Mar 2014. (B) Nutlets, Van Winkle Spring, Mohave National Preserve, San Bernardino Co., CA, 19 Mar 2004, photo by Jim Andre (CalPhotos). (C) Nutlets, bar = 1 mm, Anza-Borrego State Park, San Diego Co., CA, 28 Mar 1998, *Young 12* (SDSU 12802), by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/pectocarya/taxa/P_recurvata/>

Phacelia

The phacelias in the flora area are glandular pubescent and can cause unpleasant dermatitis, and most are stinky. Cool-season ephemerals and one perennial (*P. ramosissima*). Leaves mostly alternate, entire, pinnate or bipinnate, and petioled (at least the lower, larger leaves). Inflorescences of scorpioid cymes, coiled distally except in *P. neglecta*. Calyces lobed almost to the base. Corollas lavender, blue, or white. Seeds 4 (seldom fewer) or many.

Western hemisphere, with greatest diversity in western North America; 175 species.

There are reports that young, tender plants of these spring ephemerals were cooked as greens, but these plants, especially older ones, can be stinky and highly irritating to the skin. Rea (1997) reports that the Gila River Pimas made use of phacelias cooked as greens, but these were not highly esteemed.

1. Perennials, often woody at the base; Ajo Mountains …….. **Phacelia ramosissima**
1. Winter-spring ephemerals; widespread including the Ajo Mountains.

2. Seeds solid, more or less terete in cross-section, similar on all sides.

3. Leaf blades pinnate to pinnatifid, more than twice as long as wide.

4. Seeds many per capsule ..…… …….. **Phacelia affinis**
4. Seeds 4 per capsule …….. **Phacelia distans**

3. Leaf blades more or less ovate, shallowly lobed; about as long as wide.

5. Stems thick and succulent; inflorescences generally not taller than the leaves; seeds 0.7–0.9 mm long ..…….. **Phacelia neglecta**

5. Stems not noticeably thick and succulent; inflorescences taller than the leaves; seeds to 0.5 mm long..... **Phacelia rotundifolia**

2. Seeds boat-shaped, one side of each seed excavated (with a cavity) on either side of a septum (a ridge down the middle), the other side of the seed convex.

6. Fruiting pedicels 4–7 mm long, longer than the capsules; fruiting sepals 5–6.5 mm long, about twice as long as the capsules. ..... **Phacelia pedicellata**
6. Fruiting pedicels mostly 1–1.5 mm long, shorter than capsules; fruiting sepals 3–5 mm long, about as long to ¼ longer than the capsules.

7. Seeds 2.2–3.5 mm long, red-brown, the margins and ventral surface of the same color as the seed body (back). ..... **Phacelia crenulata**
7. Seeds 1.5–3 mm long, the margins and ventral surface paler (tan) than, and sharply differentiated from, the darker brown seed body (back).

8. Stamens exserted (conspicuously longer than the corollas). ..... **Phacelia bombycina**
8. Stamens often not exserted (as long as or shorter than the corollas). ...**Phacelia coerulea**

Phacelia affinis A. Gray
Limestone phacelia. Figure 27.

Leaves mostly basal and on the lower stems, (1.5) 3–6 cm long, pinnately lobed to pinnatifid, mostly narrowly oblong; upper leaves reduced. Inflorescences branches slightly to moderately curled distally. Flowers white, occasionally pale purple, with a pale yellow-green throat. Seeds many, nearly 1 mm long, solid, similar on both sides, transversely corrugated.

Mostly in the northern part of the Organ Pipe, wash banks at lower elevations, and rocky slopes at middle to upper elevations in the Ajo and Puerto Blanco Mountains.

Arizona to northwestern Sonora, southwestern New Mexico, southwestern Utah, southern Nevada, and southeastern California to Baja California Sur.

OP: Estes Canyon, 25 Feb 1978, *Bowers 1069* (ORPI). SE Puerto Blanco Mts, slopes above main campground, *Rutman 31 Mar 1998* (ORPI). Kuakatch Wash, 0.5 mi E of Hwy 85, *Rutman 9 Apr 1998* (ORPI).

Phacelia bombycina Wooton & Standley
Mangas Spring phacelia. Figure 28.

Leaves oblong to ovate, pinnately lobed, cleft, or crenate. Inflorescence branches strongly coiled distally. Flowers nearly sessile. Sepals 2.5 mm long. Corollas pale purple. Stamens exserted. Seeds 4 per capsule, probably 1.5 mm long; outer surface dark brown, convex, and alveolate (minutely pitted and reticulate); inner surface and margins light tan; inner surface excavated on each side of a prominent ridge, the ridge prominently corrugated (lumpy) on one side, the margins less prominently corrugated.

Known from a single record in Cabeza Prieta (perhaps more common since the plants superficially resemble those of *P. crenulata*). Also recorded in the mountains near Ajo and northward and eastward in Arizona. Arizona, southwestern New Mexico, northern Baja California, northern Sonora, and probably northwestern Chihuahua.

CP: Scarface Mt, UTM 3565000N, 317500E 12, 1650 ft, limestone and coarse sand, *Autenreith 20 Mar 1992* (ASC, det. N.D. Atwood, 14 Jan 2004).

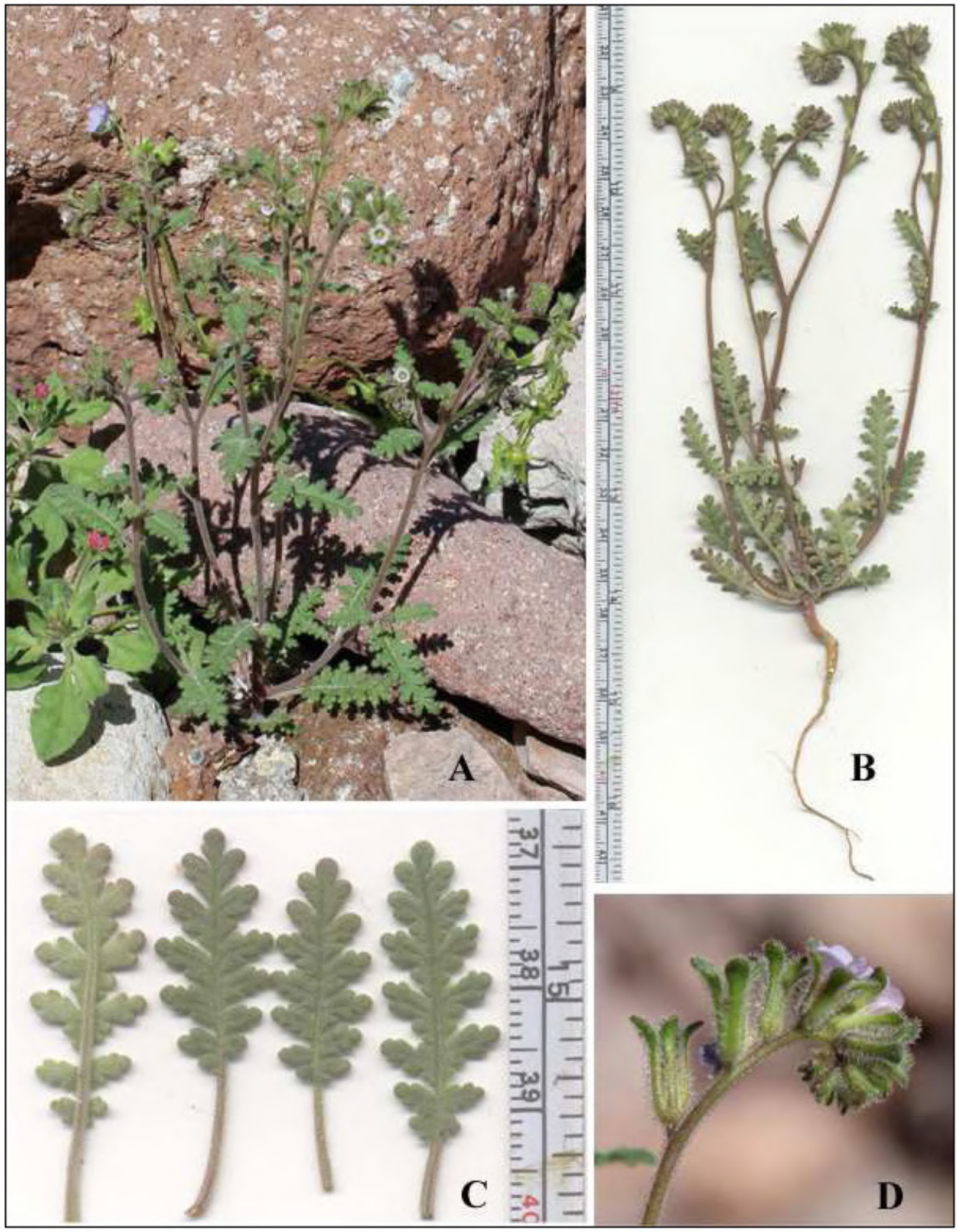

Figure 27. *Phacelia affinis*. Alamo Well: (A) 11 Mar 2014; (B & C) 16 Mar 2014; (D) 26 Feb 2014.

Figure 28. *Phacelia bombycina*. (A) Hills west of Coffeepot Mtn, Sauceda Mts, Pima Co., 25 Feb 2012. (B) Courthouse Butte, Sedona, Yavapai Co., 17 Feb 2003, photo by Max Licher (SEINet).

Phacelia coerulea Greene
Skyblue phacelia. Figure 29.

Leaves oblong to ovate, pinnately lobed, cleft, or divided. Inflorescence branches coiled to one side distally. Flowers whitish to pale lavender with a white center. Stamens often not exserted (as long as or shorter than the corollas). Seeds 4 per capsule, 1.5–3 mm long; outer surface dark brown, convex, and alveolate (minutely pitted and reticulate); inner surface and margins paler (tan) than and sharply differentiated from dark brown body (back), the margins incurved; inner surface excavated on each side of a prominent ridge, and corrugated (lumpy) on one side.

Widely scattered in Organ Pipe and in the eastern part of Cabeza Prieta and at Cabeza Prieta Tanks.

Southern Arizona to western Texas and Utah, southeastern California, Chihuahua and northern Sonora.

Some plants in the flora area identified as *P. coerulea* resemble *P. crenulata* var. *ambigua*, but *P. coerulea* tends to have more slender stems, the leaves tend to have larger and more rounded lobes, the corollas are paler, the stamens usually shorter than the corollas indicating autogamous (selfing) flowers (plants clearly resembling *P. coerulea* sometimes have well-exserted stamens, especially when well-watered), and the seeds are not as smooth and the margins are distinctive. In Alamo Canyon *P. coerulea* grows intermixed with *P. crenulata*, and the plants are easily distinguished; *P. coerulea* also occurs intermixed with *P. affinis* and *P. distans*.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10824*. Alamo Canyon, *Nichol 14 Mar 1939*. Arch Canyon, 5 Apr 1978, *Bowers 1172* (ORPI). Hills to E of Senita Basin, *Rutman 10 Mar 1998* (ORPI).
CP: Cabeza Prieta Tanks, 6 Apr 1979, *Lehto L 23535* (ASU).

Figure 29. *Phacelia coerulea*. Alamo Well, 11 Mar 2014.

Phacelia crenulata Torrey ex S. Watson var. **ambigua** (M.E. Jones) J.F. Macbride
[*P. ambigua* M.E. Jones. *P. ambigua* var. *minutiflora* (J.W. Voss) N.D. Atwood]
Desert heliotrope. Figure 30.

Herbage stinky and irritating, sticky-viscid with spreading white hairs, and minutely glandular above. Stems often 10–30 (45+) cm tall, mostly erect, simple or several-branched. Larger leaves basal and often also on the lower stem, often 3–15 cm long, pinnatifid or the lower segments cleft to the midrib or into separate leaflets; leaves reduced upwards. Inflorescence simple to several-branched, coiled to one side distally. Flowering and fruiting pedicels often 1–1.5 mm long. Flowers moderately fragrant; corollas lavender with a white tube, 4–8 mm long. Stamens exserted. Fruiting sepals 3–5 mm long, about as long as to ¼ longer than the capsules. Seeds 4 per capsule, 2.2–3.5 mm long, boat-shaped, red-brown, alveolate (minutely pitted and reticulate), the outer surface convex, the inner surface excavated on each side of a prominent ridge, the ridge corrugated on one side, the margin smooth (not corrugated) and not differentiated from the body (back).

This is the most abundant and widespread phacelia in the region, occurring in many habitats including washes, canyons, bajadas, plains, dunes and rocky slopes often to their summits. Fossils more than 8000 years old were found in the Ajo Mountains.

Contact with *Phacelia crenulata* and other *Phacelia* species can cause phacelia dermatitis (*Dermatitis venenata*), which is a painful rash similar to poison ivy rash (Berry et al. 1962, Munz 1932). About 10 percent of the general population is susceptible. In years when *Phacelia crenulata* is abundant, visitors afflicted with the rash arrive at the Organ Pipe visitor center asking about its cause. In severe cases, victims need hospitalization.

The *ambigua* taxon occurs in Arizona to northwestern Sonora, southern Nevada, and southeastern California to Baja California. The taxonomy of the *P. crenulata* complex can be complicated and confusing: calling the flora area population *P. crenulata* var. *ambigua* seems to be the most reasonable choice, and consistent with The Jepson Manual (Patterson et al. 2003). Several varieties of *P. crenulata* are often recognized, extending across much of southwestern North America.

OP: Tres Alamos Canyon, *Nichol 24 Feb 1939* (ORPI). Puerto Blanco Mts, *Nichol 24 Feb 1939* (det. *P. minutiflora*, Atwood & Smith 1994). Road to Dripping Springs, 20 Mar 1941, *McDougall 2*. Near road 5 mi N of Sonoyta, 22 Mar 1941, *McDougall 16* (det. as *P. minutiflora*, Atwood & Smith 1994). Quitobaquito, 18 Mar 1945, *Gould 2999* (det. *P. minutiflora*, Atwood & Smith 1994). Bajada at Sierra de Santa Rosa, 11 Feb 1978, *Bowers 1028*. 2 mi E of Bates Well, 30 Mar 1979, *Bowers 1596* (det. as *P. ambigua*, Atwood & Smith 1994). †Alamo Canyon: seed (2.9 mm long, margin not well differentiated), 1150 ybp; seed, margin not differentiated, 8130 ybp

CP: Sam Clark Mine, (Little Ajo Mts), 1800 ft, *Simmons 10 Mar 1963*. Tuseral Tank (Simmons 1966). Dunes, S of Las Playas, lava field, 10 Apr 1978, *Reeves 6766* (ASU). E side of Pinacate Lava, 21 Mar 1992, *Harlan 98*. Charlie Bell Road near E boundary of Refuge, 9 Apr 1993, *Felger 93-318*. Cabeza Prieta Peak, S side summit, 2550 ft, 24 Mar 1995, *Yeatts 3665* (CAB).

TA: Tinajas Altas: Mar 1937, *Harbison 16820*; *Van Devender 5 Mar 1983*. Coyote Water, 21 Feb 2005, *Felger 05-128*. 0.3 mi E of Fortuna Mine, Gila Mts, 760 ft, Van Devender 31 Dec 1972 (det. *P. ambigua*, Atwood & F.J. Smith 1994).

Phacelia distans Bentham
Caterpillar phacelia, fernleaf phacelia. Figure 31.

Plants simple to often much-branched and spreading, the stems slender and leafy, 15–45+ cm long including inflorescences. Herbage moderately sticky with conspicuous white hairs, sometimes with swollen white bases, and also sessile glands, golden when fresh. Leaves fern-like, 6–17 cm long, 1- or 2-times pinnatifid, the segments pinnately lobed or toothed to pinnatifid. Inflorescences coiled to one side distally. Calyx lobes moderately enlarging in fruit, reaching 6+ mm long. Corollas

(7) 8–9.5 mm long, pale violet to blue, the lobes spreading. Seeds 4 or fewer, 2 mm long, solid, and similar on both sides.

Widespread in Organ Pipe and the eastern part of Cabeza Prieta; washes, bajadas, canyons, and rocky slopes including higher elevations. Often growing in the protection of spiny shrubs.

In many life zones, western and southern Arizona, and western and northern Sonora, southern California, Baja California, and southern Nevada.

Figure 30. *Phacelia crenulata* var. *ambigua*. (A) Hwy 2 near Los Vidrios, Pinacate Biosphere Reserve, Sonora, 17 Mar 2014. (B–D) Bates Mts, 2 Mar 2008.

Figure 31. *Phacelia distans*. (A) Alamo Well, 11 Mar 2014. (B) Trail to Victoria Mine, Puerto Blanco Mts, 4 Mar 2008. (C) Victoria Mine Trail, 15 Mar 2008.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10853*. Alamo Canyon, *Nichol 4 May 1939*. Bates Well, 22 Apr 1942, *Cooper 731*. Aguajita, 6 Apr 1988, *Felger 88-280*. Kuakatch Wash, E Monument boundary, *Rutman* 4 Apr 1998 (ORPI). Trail from The Cones to Mount Ajo, 4090 ft, 10 Apr 2005, *Felger 05-284*.

CP: Papago Well, *Crooks 31 Mar 1937*. Agua Dulce Springs (Simmons 1966). San Cristobal Wash, 27 Mar 1976, *McManus 661*. 2 mi S of Camino del Diablo on E boundary of Refuge, 26 Feb 1993, *Felger 93-79*.

Phacelia neglecta M.E. Jones
Alkali phacelia. Figure 32.

Plants semi-succulent, often less than 6–8 cm tall, the root and main stem notably thick. Leaves semi-succulent, petioled, the blades mostly 5–25 mm wide, broadly ovate to orbicular, the margins wavy to shallowly toothed. Corollas white. Unlike most phacelias, the plants are not stinky and the inflorescences with relatively few flowers, not appearing coiled distally. Seeds numerous, 0.7–0.9 mm long, solid, similar on both sides, resembling tiny insect pupae.

Western part of Organ Pipe and widely scattered through Cabeza Prieta and Tinajas Altas. Generally localized on desert pavements and sandy soils, often in otherwise nearly barren areas.

Western Arizona, northwestern Sonora, southeastern California, and southern Nevada.

OP: Flats N of Custom House, 1 mi N of Sonoyta (Arizona), 22 Mar 1941, *McDougall 18*. 3 mi S of Growler Mine, 21 Mar 1941, *McDougall 93*. 2 mi WSW of Bates Well, 30 Mar 1978, *Bowers 1128* (ORPI). 8.6 mi W of Hwy 85 on road to Quitobaquito, 2 Mar 1985, *Van Devender 85-8*.

CP: Cabeza Prieta Tanks, 6 Apr 1979, *Lehto L23540* (ASU). SE of Las Playas, desert pavement, 10 Apr 1978, *Lehto L22455* (ASU). Packrat Hill, 25 Feb 1993, *Felger 93-59*. 1 km N of Tule Well, 11 Apr 1993, *Felger 93-439*.

TA: E margin of Davis Plain, W side of Tinajas Altas Mts, W branch of Camino del Diablo, decomposed granite pediment directly downslope from rocky hill, 20 Feb 2005, *Felger 05-62*.

Figure 32. *Phacelia neglecta*. (A) Mojave National Preserve, San Bernardino Co., CA, 2010, photo by Genevieve K. Walden (SEINet). (B) Chocolate Mts, Imperial Co., CA, 1999, photo by Donald Myrick (CalPhotos).

Phacelia pedicellata A. Gray
Pedicellate phacelia. Figure 33.

Plants robust, stems often 10–45+ cm long, relatively thick and semi-succulent, and leafy. Herbage pale green, viscid glandular-hairy and notably stinky. Leaves 5–16+ cm long, pinnatifid to pinnately compound, and semi-succulent. Inflorescence coiled to one side distally. Flowers on slender pedicels, the fruiting pedicels 4–7 mm long. Calyx lobes elongated; fruiting sepals 5–6.5 mm long, about twice as long as capsules. Corollas pale lavender-blue. Seeds 4 per capsule, 2.5–3.1 mm long, boat-shaped, red-brown; outer surface convex and pitted; inner surface excavated both sides of a prominent ridge.

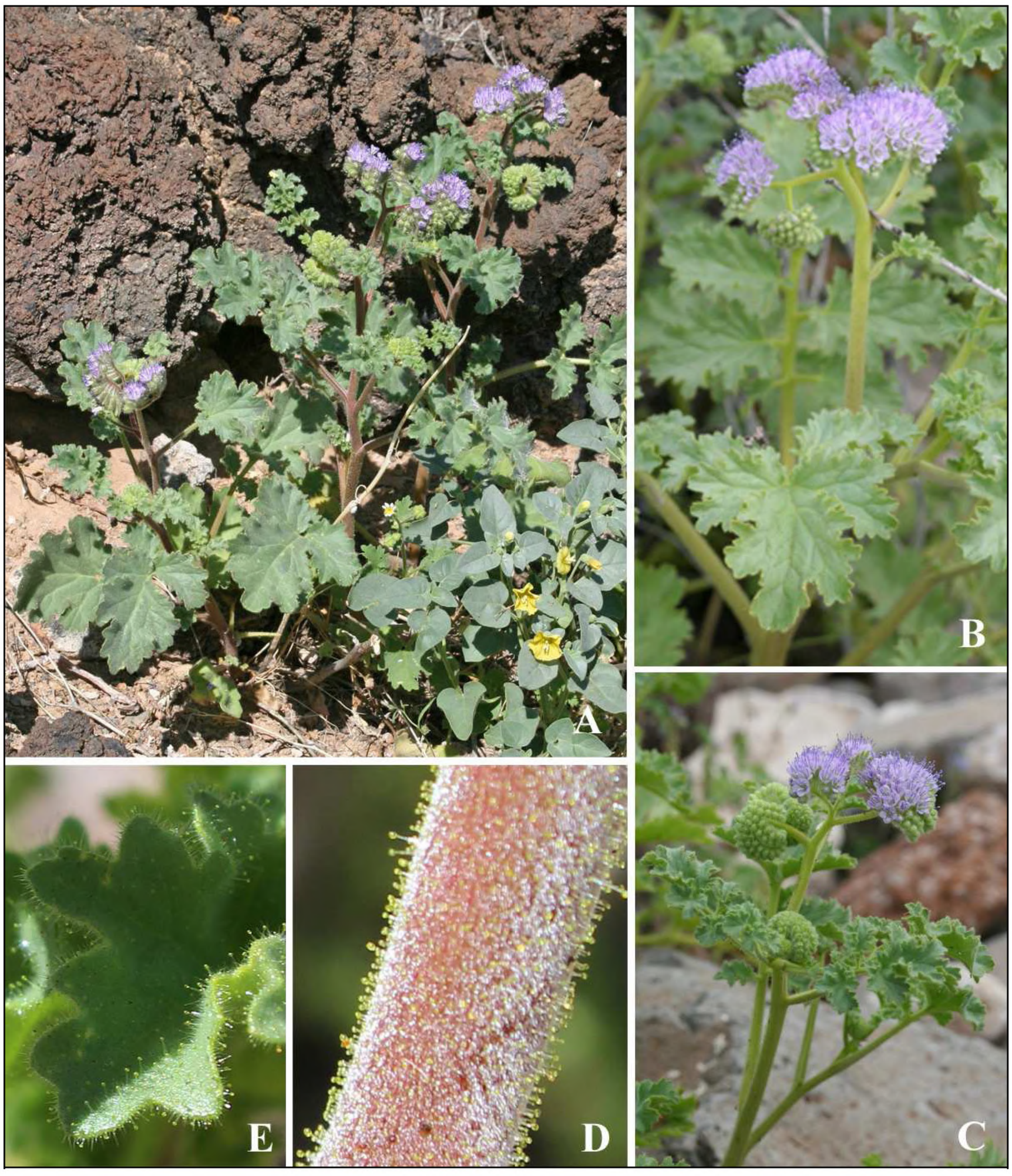

Figure 33. *Phacelia pedicellata.* (A) Near Red Cone campground, Pinacate Biosphere Reserve, Sonora, 7 Mar 2009. (B & C) Drainage NW of Kino Peak, Bates Mts, 20 Mar 2005. (D & E) Viscid, glandular-hairy stem and leaf blade, Estes Canyon near trailhead, 7 Mar 2014.

Scattered across the flora area including the Ajo Mountains, often in sandy-gravelly washes and shallow soils on tuff. This species, *Chenopodium watsonii*, and *Clerodendron coulteri* (*Tetraclea coulteri*) are the stinkiest plants in the flora area.

Western Arizona, northwestern Sonora, southeastern California, and eastern Baja California.

OP: Arch Canyon, 28 Mar 1965, *Niles 552.* Dripping Springs, *Wirt 5 Mar 1991* (ORPI). Estes Canyon, *Rutman 15 Apr 1998* (ORPI). Wash 1.2 mi NW of Kino Peak, 20 Mar 2005, *Rutman 2005-0320-9* (ORPI).

CP: T13S, R13W, SE¼, 26 Feb 1977, *Irwin 93* (ASU).

TA: Tinajas Altas, canyon bottom E of tinajas, 19 Mar 1998, *Felger 98-145.*

Phacelia ramosissima Douglas ex Lehmann
[*P. ramosissima* var. *latifolia* (Torrey) Cronquist]
Branching phacelia. Figure 34.

Perennial herbs often to 1 m or more wide. Leaves pinnately lobed to twice-divided. Inflorescences coiled to one side distally. Corollas pale blue. Seeds 2–4 per capsule, probably 2.5–3 mm long, pitted, and with a ventral ridge but scarcely excavated.

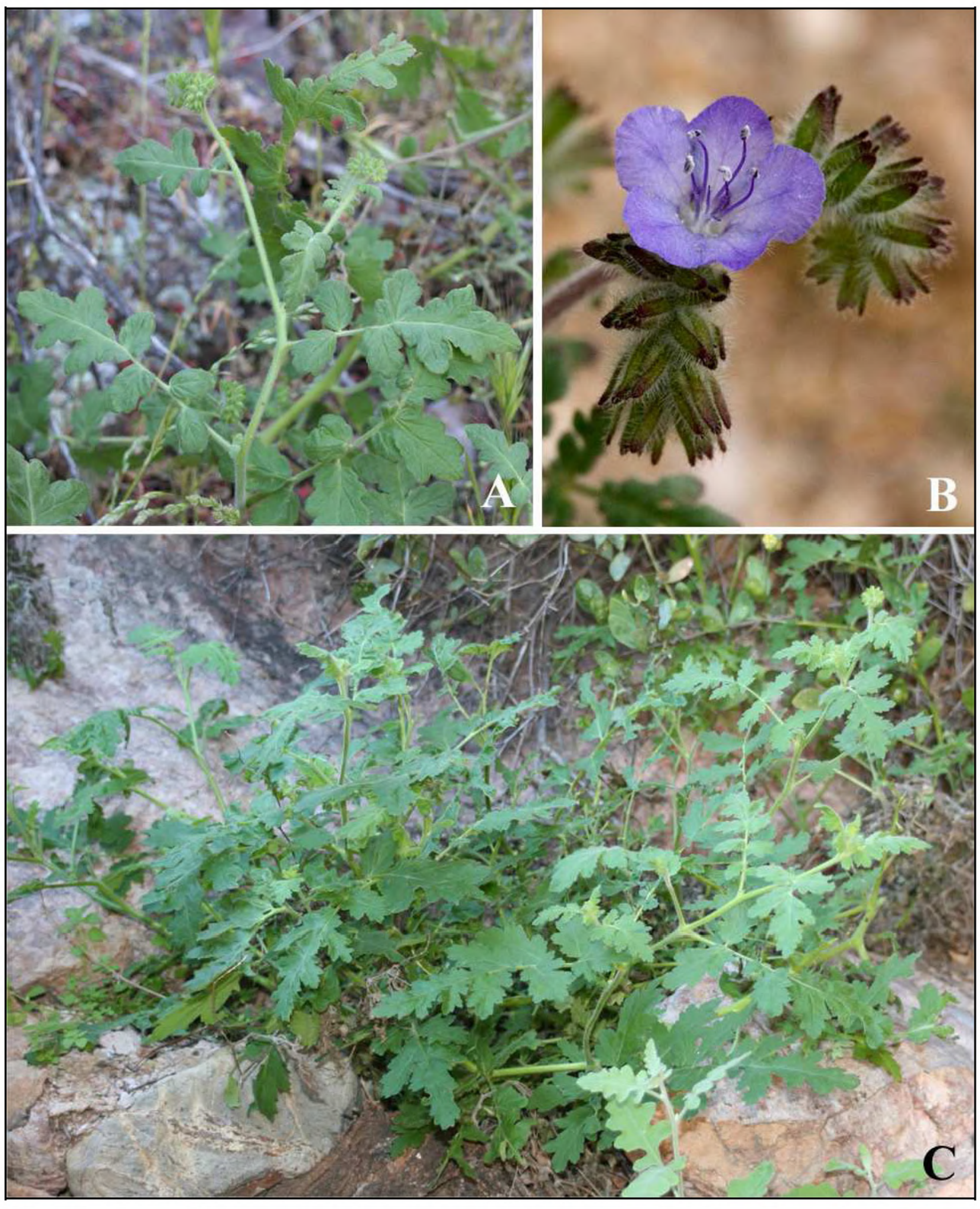

Figure 34. *Phacelia ramosissima.* (A & C) Base of N-facing cliff above Bull Pasture, 10 Apr 2005. (B) Catalina State Park, Pima Co., 22 Feb 2009, photo by Patrick Alexander (SEINet).

Middle to higher elevations in the Ajo Mountains, in coarse alluvium along washes, in shady sites, and under trees; apparently not widespread and not common.

This species occurs from Washington to Baja California, Utah and Arizona, but generally not in deserts. Four varieties are sometimes recognized; var. *latifolia* is the southernmost one.

Robust plants of *P. distans* in the Ajo Mountain superficially resemble *P. ramosissima*. Above Bull Pasture on 10 April 2005, *P. ramosissima* was in bud and just beginning to flower while the *P. distans* plants had dry fruits.

OP: Alamo Canyon: 15 Dec 1939, *Harbison 26261*; 2000 ft, *Tinkham 18 Apr 1942*. Bull Pasture, 2800 ft, perennial, flowers blue, 2 May 1978, *Bowers 1270* (ARIZ, annotated as *P. cryptantha* by Richard Halse, 1999, but the label says "perennial" and *P. cryptantha* is an ephemeral and is not known from Organ Pipe). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-265*.

Phacelia rotundifolia Torrey ex S. Watson

Roundleaf phacelia. Figure 35.

Plants generally less than 15 cm tall and often much smaller. Leaf blades more or less ovate, shallowly lobed, about as long as wide, and with scalloped margins. Inflorescences coiled to one side distally, taller than the leaves; flowers white or faintly pink. Seeds numerous and minute, 0.5 mm long, pitted and reticulate.

Known from a single record at the boundary of the flora area, which is one of the southernmost records for this species.

Either rare and/or seldom recorded in southwestern Arizona. Often growing in rock crevices; western Arizona and deserts in southern Utah, southern Nevada, and southeastern California.

OP: 100 m N of Organ Pipe and 0.5 km E of Cabeza Prieta NWR, 1700 ft, crevice of rock face, 13 Mar 1993, *Christy 1263* (ASU).

Figure 35. *Phacelia rotundifolia*. (A) Eagle Tail Mts, central-west AZ, photo by John Alcock (SEINet). (B) Table Top Mtn, below SW side of peak, Maricopa Co., 10 Mar 2008, photo by Patrick Alexander (SEINet). (C) Photo by Dave Sussman (SEINet).

Pholistoma

This genus includes three species in California, Arizona, Baja California, and northwestern Sonora.

Pholistoma auritum (Lindley) Lilja var. **arizonicum** (M.E. Jones) Constance
Blue fiesta-flower. Figure 36.

Cool-season ephemerals. Stems square in cross section, brittle and semi-succulent, weak and scrambling through bushes and across rocks. Herbage and calyx with curved hairs that hook onto animals and clothing. Lower leaves opposite, the upper ones alternate; leaves thin, often 3–6 (8) cm long, pinnately lobed. Flowers 1 or few in axillary or terminal cymes. Calyx enlarging in fruit, often ±1.5 cm wide, and with conspicuous auricles often 4–6.5 mm long. Corollas blue. Fruits of globose capsules; seeds 1–4. No other member of the family in the flora area has long, scrambling, weak stems, and clinging, hooked hairs.

Widespread across Organ Pipe, especially in the mountains, and in the eastern part of Cabeza Prieta; washes, upper bajadas, canyons, and rocky slopes, often north-facing and beneath shrubs.

Figure 36. *Pholistoma auritum* var. *arizonicum*. Estes Wash near Bull Pasture Trailhead: (A) 31 Mar 2008; (B) 16 Feb 2005. (C) Alamo Canyon, 26 Feb 2014.

Variety *arizonicum* occurs in western and central Arizona, and northwestern Sonora. Variety *auritum* occurs west of the deserts in California and Baja California.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10817*. Alamo Canyon, 14 Mar 1941, *Benson 10677*. Dripping Springs, 15 Apr 1952, *Parker 7907*. Bull Pasture Trail, 2800 ft, 2 May 1978, *Bowers 1270* (ORPI).
CP: 1.8 mi N of Adobe Windmill, 25 Feb 1993, *Felger 93-62*. Agua Dulce Mts, 26 Feb 1993, *Felger 93-94*. Charlie Bell Road near E Refuge boundary, 9 Apr 1993, *Felger 93-319*. Childs Mountain, 25 Feb 1993, *Felger 93-40*.

Plagiobothrys – Popcorn-flower

Cool-season ephemerals (elsewhere sometimes perennials or bona fide annuals), the herbage pubescent. Leaves basal and cauline, simple, linear to oblanceolate, green, with or without a red-purple midrib and margins. Inflorescences of scorpioid cymes, coiled distally. Flowers small; corollas funnelform to rotate, white or white with a yellow tube and corolla appendages, the limb 1–3 mm wide. Fruits homomorphic, with 2–4 nutlets, the nutlets widely lanceolate to widely ovate, dorsal surface coarsely roughened or tessellate; attachment scar narrowly triangular to linear or ± round, along an elongated ventral keel or at base of a short ventral keel.

The genus is amphitropical in the Americas, mostly in western North America and temperate South America, including 80–90 species; it is not, however, monophyletic.

1. Plants staining red-purple when pressed; fruiting calyx separating around the middle (circumscissile); nutlets 1.5–2.5 mm long, the attachment scar more or less round and at the base of a short ventral keel..... **Plagiobothrys arizonicus**
1. Plants not red-staining; calyx not circumscissile; nutlets 2.5–3 mm long, the attachment scar narrowly triangular to linear along a prominent ventral keel..... **Plagiobothrys jonesii**

Plagiobothrys arizonicus (A. Gray) Greene ex A. Gray
Arizona popcorn-flower. Figure 37.

Plants often 10–40 cm tall. Roots, leaf mid-veins and margins red-purple and staining same color when pressed. Plants with sharp, spreading hairs often with a hard swollen base as well as smaller, softer hairs. Leaves lanceolate to linear-oblanceolate, the larger, lower leaves 3–8 cm long, Calyx body rounded, the lobes free distally; fruiting calyx separating around the middle (circumscissile). Corollas white, sometimes with yellow tube, center, and appendages. Nutlets 2, 1.5–2.5 mm long, broadly ovate, strongly arched or folded in profile, with tubercles along dorsal and lateral ribs, and firmly attached, the attachment scar more or less round and at the base of a short ventral keel.

Sandy loams of plains in the northeastern and north-central part of Organ Pipe. Its history in Organ Pipe extends to 20,500 years.

Southern California to southern Utah, Arizona, northern Sonora, and presumably in northernmost Baja California.

OP: Hwy 85, 1 mi S of N boundary of Monument, *Rutman 2 Apr 1998* (ORPI). Kuakatch Wash near E boundary, 2 Mar 2003, *Rutman 2003-217* (ORPI). Armenta Rd, 1.4 mi W of Hwy 85, 11 Mar 2003, *Felger 03-271*. †Montezuma's Head, nutlets, 13,500 & 20,490 ybp.

Figure 37. *Plagiobothrys arizonicus*. (A) Hwy 86 between road to Kitt Peak and Sells, Pima Co., 19 Mar 2010. (B) Abaxial leaf surface, with bulbous-based hairs and red leaf margin and midvein, Tyrone Ridge Access Road, Grant Co., NM, 10 Mar 2010, photo by Russell Kleinman (gilaflora.com). (C) Sedona, Yavapai Co., 17 April 2001, photo by Max Licher (SEINet).

Plagiobothrys jonesii A. Gray
Mojave popcorn-flower. Figure 38.

Plants (8) 12–45 cm tall, not red-staining; with coarse hairs. Leaves lanceolate to oblanceolate, larger, lower leaves 4–8 cm long, with bulbous-based hairs. Calyx deeply 5-lobed, not circumscissile. Corollas white with a yellow center. Nutlets 3 or 4, ovate-triangular, 2.5–3 mm long, not strongly arched, the attachment scar narrowly triangular to linear along a prominent ventral keel.

Known from several records in the flora area. It is common north and east of the flora area in the Maricopa and Baboquivari Mountains.

Southern California to southwestern Utah, Arizona, and northern Sonora.

This species strongly resembles *Amsinckia* but differs in having a white corolla; Johnston (1923) placed it in *Plagiobothrys* section *Amsinckiopsis* owing to this morphological similarity. Phylogenetic analyses by Matt Guilliams (unpublished data) place this taxon nearer to *Amsinckia* rather than within *Plagiobothrys*, and the appropriate nomenclatural change will be made at a later time.

OP: Twin Peaks, steep S-facing volcanic slope, 1900 ft, *Van Devender 19 Feb 1984.* W side Sierra Santa Rosa, 485 m, upper bajada, 12 Mar 2003, *Felger 03-345*.

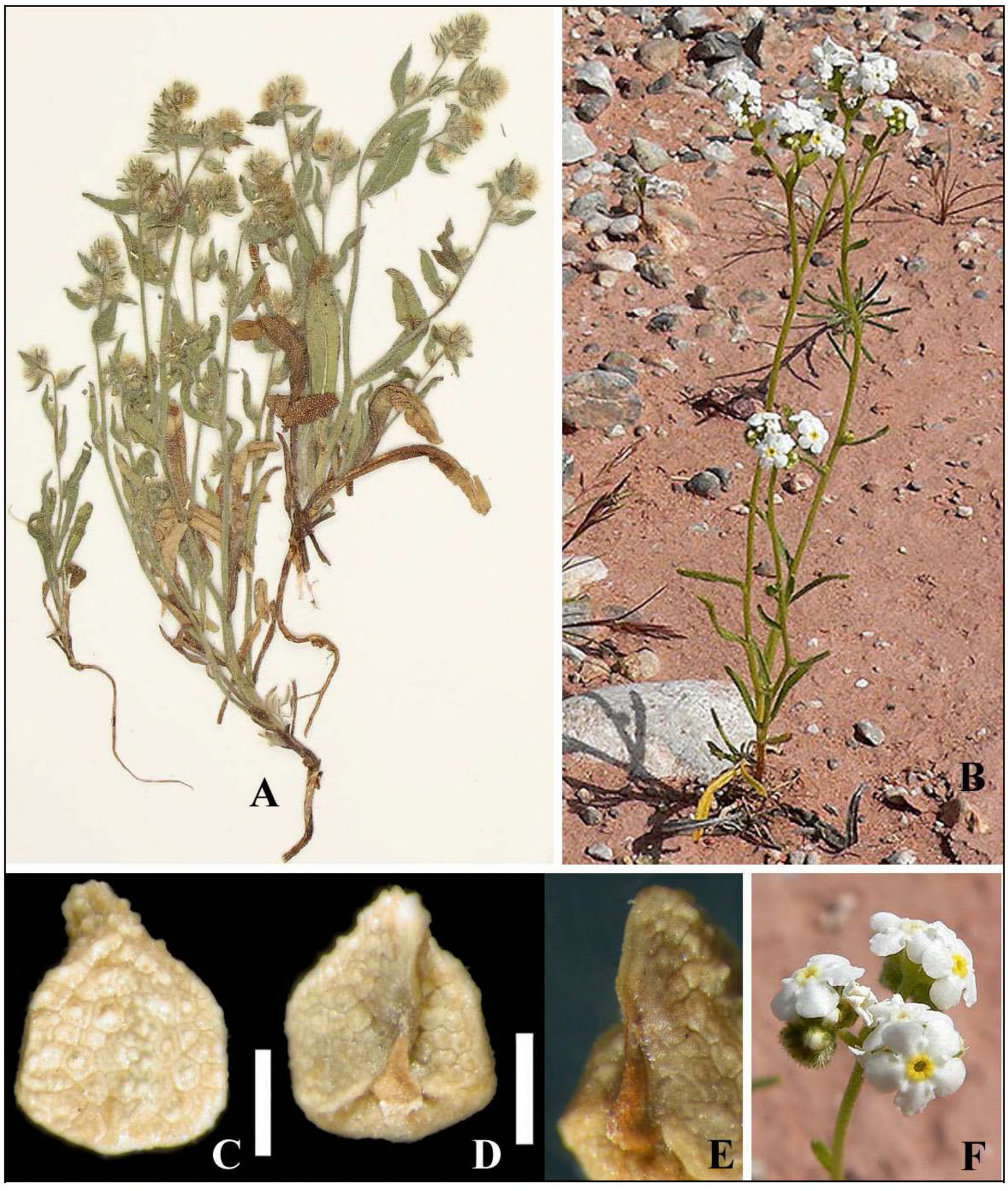

Figure 38. *Plagiobothrys jonesii*. (A) Cady Mts, Mojave Desert, San Bernardino Co., CA, 25 Mar 2009, *Sanders 36595* (DES, UCR). (B & F) N end of Red Rock Canyon, Clark Co., NV, 13 Apr 2005, photo by Stan Shebs (SEINet). (C–E) Nutlet, Providence Mts, San Bernardino Co., CA, 24 Apr 1960, *Howe 2875* (SDSU 5441), by Michael G. Simpson and students, <http://www.sci.sdsu.edu/plants/plagiobothrys/taxa/PL_jonesii/>

Tiquilia

Small, low-growing herbaceous or subshrub perennials, sometimes flowering in first season. Stems with a forked branching pattern (pseudo-dichotomous). Herbage densely and variously hairy. Leaves simple, with revolute (inrolled) margins. Flowers essentially sessile, axillary, single or clustered. Corollas lavender or pinkish. Fruits dry, with 1–4 nutlets.

North and South America in dry regions, mostly deserts; 27 species.

1. Branches alternate; leaf veins obscure and covered by a dense layer of hairs; rocky habitats. ..... **Tiquilia canescens**
1. Branches opposite; leaves with several pairs of conspicuous, impressed veins; sandy habitats.

2. Leaves with 2 or 3 (4) pairs of shallowly impressed veins; nutlets rounded, minutely papillate to dull-surfaced, not smooth and shiny..... **Tiquilia palmeri**
2. Leaves with 5 or 6 (7) pairs of deeply impressed veins, appearing as if pleated; nutlets ovoid, smooth and shiny..... **Tiquilia plicata**

Tiquilia canescens (A. de Candolle) A.T. Richardson
[*Coldenia canescens* de Candolle]
Woody crinklemat. Figure 39.

Figure 39. *Tiquilia canescens*. (A & D) Trail between Twin Peaks Campground and Victoria Mine, OP, 27 Mar 2008. (B) Near Bluebird Mine, Growler Mts, 9 Mar 2014. (C) Page Springs Road by US Hwy 89A, Yavapai Co., 8 Jun 2009, photo by Max Licher (SEINet).

Dwarf, subshrub perennials with short, spreading branches, the stems with spreading hairs. Foliage scruffy gray, the leaves about 1 cm long, ovate to elliptic, with soft, whitish-gray hairs. Flowers pale lavender; with spring and summer-fall rains.

A calciphile on rocky ledges and mesas; Organ Pipe in the Gunsight Hills and Puerto Blanco Mountains and scattered mountains and hills in Cabeza Prieta.

This species occurs in southeastern California to southwestern Utah, New Mexico, and Texas, the Baja California Peninsula, northern Sonora and the Chihuahuan Desert Region in north-central Mexico. Two varieties, distinguished primarily by flower size, are sometimes recognized: var. *canescens* and var. *pulchella* (I.M. Johnston) A.T. Richardson. Both are reported from southwestern Arizona.

OP: 13.5 mi by road NW of Visitor Center, Puerto Blanco Drive, 10 May 1979, *Bowers 1716*. Gunsight Hills, 2 Mar 2003, *Rutman 2003-211*. W end Puerto Blanco Mts, 0.6 mi N of Golden Bell Mine, 14 Mar 2003, *Rutman 2003-315* (ORPI).

CP: Cabeza Prieta Mts, 0.6 mi SW Tule Tank, 1250 ft, *Van Devender 9 Mar 1980*. Scarface Mt, S-facing limestone slope, 1650 ft, *Tallarovic 20 Mar 1992* (ASC). Childs Mt, 2750 ft, 18 Aug 1992, *Felger 92-643A*. Cabeza Prieta Peak, near summit, 24 Mar 1995, *Yeatts 3658* (CAB).

Tiquilia palmeri (A. Gray) A.T. Richardson
[*Coldenia palmeri* A. Gray]
Palmer's crinklemat. Figure 40.

Low-growing, semi-prostrate perennials from very slender roots issuing from even deeper, very thick, long, black roots. Stems very slender, not woody. Petioles prominent, often as long as or longer than the blades; leaf blades 3–8 mm long, broadly elliptic to ovate, rhombic, or nearly orbicular, with conspicuous but shallowly impressed veins on the upper surfaces. Herbage densely pubescent with white hairs and scattered bristles with swollen bases. Flowers lavender-pink with a pale yellow throat; flowering with spring and summer-fall rains. Nutlets 0.8–0.9 mm diameter, 1–4 per fruit, rounded (spheroid).

Sand flats and dunes of the Pinta Sands and near the Butler Mountains.

Southeastern California, southern Nevada, western Arizona, Baja California, and northwestern Sonora.

Seris made a tea from the large, thick root to alleviate stomachache or a cold (Felger & Moser 1985).

CP: Pinacate Plateau, Camino del Diablo, open sandy desert, 28 Oct 1937, *Gentry 3508* (DES). Pinta Sands, 11 Apr 1993, *Felger 93-410*.

TA: Butler Mts, *Van Devender 27 Mar 1983*.

Tiquilia plicata (Torrey) A.T. Richardson
Figure 41.

Plants resembling *T. palmeri* in growth form and habit, but readily distinguished by having more prominent and a larger number of leaf veins. Common on dunes and sandy habitats in the nearby Gran Desierto of Sonora as well as the Mohawk Dunes and near Yuma. It is not known from the flora area although the Pinta Sands near the Sonora border seem like suitable habitat.

Figure 40. *Tiquilia palmeri*. Cinder plains on road to Red Cone campground, Pinacate Biosphere Reserve, 3 Mar 2009.

Figure 41. *Tiquilia plicata*. (A) Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora, 19 Feb 2005. (B) Sandy wash below Gillespie Dam, Maricopa Co., 31 Mar 2013.

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